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CAPE COD COMMISSION TECHNICAL BULLETIN
92-001

ESTIMATION OF HIGH GROUND-WATER LEVELS FOR CONSTRUCTION AND LAND USE PLANNING — A CAPE COD, MASSACHUSETTS, EXAMPLE — UPDATED 1991

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COUNTY OF BARNSTABLE MASS

CAPE COD COMMISSION

PREPARED IN COOPERATION WITH THE
U.S. GEOLOGICAL SURVEY,
WATER RESOURCES DIVISION

932/30

Falmouth Enterprise 8/25/81

Reducing Guesswork In Ground Water Study

The U.S. Geological Survey (USGS) has removed a lot of the guesswork for determining ground water levels before installation of septic systems

A new formula has been devised by USGS scientists to predict with up to 90 percent accuracy how much the ground water level will fluctuate anywhere on Cape Cod.

"The idea is based on the concept that what is happening to the water table in one place is happening in other places as well," USGS sub-district chief Michael H. Frimpter told a gathering of some 40 engineers and other professionals at a workshop yesterday at Cape Cod Community College.

"If we know what is happening (to the water level) in our observation well, we know what happens at another site where there is no well and where we're going to put in a septic system," Mr. Frimpter explained.

The information can be vital because the state Sanitary Code, Title Five, requires that septic system leaching fields be at least four feet above maximum ground water level.

The scientists proved out their theory with considerable observations taken at 13 "index" observation wells the USGS has maintained at various locations on the Cape for the last several years in addition to "more than four thousand observations taken at 149 additional, short-term wells," Mr. Frimpter said.

Money From USGS

Money for the additional wells was provided by the Survey, and the study was carried out by the USGS scientists with the cooperation of the state Department of Environmental Quality Engineering (DEQE) and the Cape Cod Planning and Economic Development Commission.

Also present with Mr. Frimpter at the workshop were Ivan C. James II, New England district chief of the USGS; Scott Horsley, the planning commission's water resources coordinator, and the commission's water resources planner, Mark Fouhy.

Each contributed to the discussion and the question and answer period that followed.

Mr. Fouhy said charts and data for each of the Cape's 15 towns have been sent to the health agents in those towns. "They have the information," he said, "But they're waiting for the engineers to use it."

Mr. Frimpter said the Cape's ground water level fluctuates. In areas near the coast, he said, "the change is small, from zero to two feet, but in the central part of the Cape, the fluctuation can be as much as five feet."

This would seem to indicate that the four feet requirement of Title Five is too stringent in some areas, but Mr. Frimpter said that DEQE has not indicated any intention of backing down on the limit yet.

He said he had talked to DEQE regional engineer Paul T. Anderson. "we discussed our system at some length," Mr. Frimpter said, "and he said 'Go ahead and use it.'"

When Level Is Highest

Mr. Frimpter said extensive observations made at wells by the scientists disclosed that the Cape's water table is at its highest level—closest to the ground surface—in the spring and winter.

"But this is not caused because it rains more in the spring and winter. It's caused by the plants using up all the water supply in the summer," he said, when the Cape's level is at its lowest.

On a master chart, the scientists broke the Cape down to five different zones, of varying ground water levels.

Each zone has an observation well from which data relative to the ground water level fluctuations apply to any site within that zone at any time of the year.

Thus, a resident planning to dig a septic system can find out by asking the local health agent what the maximum ground water level is at the location to assure that the system is four feet above that level and will function properly.

Mr. Frimpter confessed early in the workshop that the idea for the study was given to him by the planning commission's former water resources coordinator Paula Magnuson.

"Paula asked me one day, 'Why can't you do something to predict water levels?' and that's how it all began," Mr. Frimpter said.

Estimation of High Ground-Water Levels for Construction and Land Use Planning, A Cape Cod Example -- Updated 1991

By Michael H. Frimpter, U.S. Geological Survey
and Gabrielle C. Belfit, Cape Cod Commission

Cape Cod Commission Technical Bulletin 92-001

COUNTY OF BARNSTABLE
MASS

1992

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Barnstable, MA 02630

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CONVERSION FACTORS

Multiply	By	To obtain
foot (ft)	0.3048	meter
mile (mi)	1.609	kilometer

Estimation of High Ground-Water Levels for Construction and Land Use Planning, A Cape Cod, Massachusetts, Example--Updated 1991

By Michael H. Frimpter and Gabrielle C. Belfit

ABSTRACT

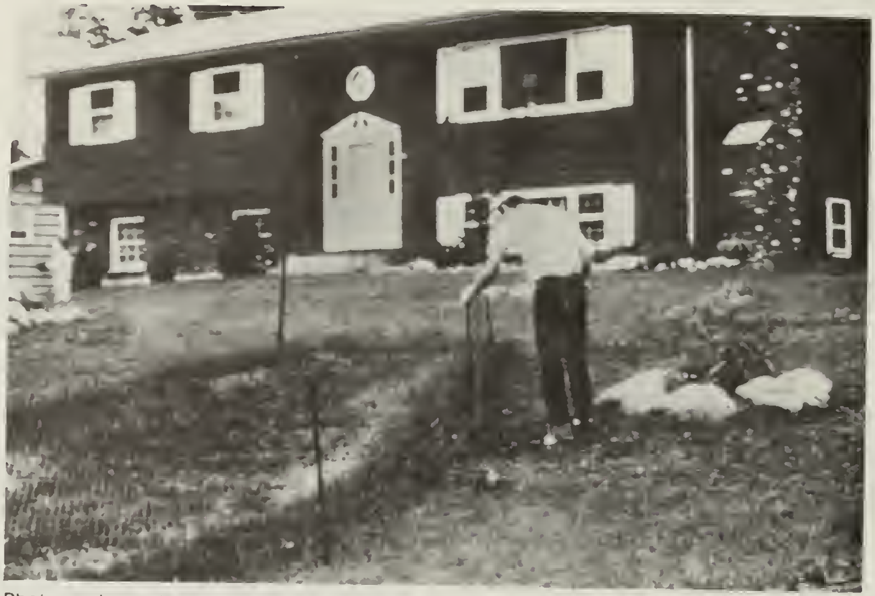
A technique for estimating the level to which ground water can rise as a consequence of weather and seasonal factors has been developed to assist the home-building industry, which designs and constructs septic systems, and health officials, who regulate septic systems. The report includes four plates that map areas where annual ground-water level ranges of 0-2 feet, 2-3 feet, 3-4 feet, 4-5 feet, and 5-6 feet are expected, and areas where water levels are best indexed to water levels in each of nine long-term observation wells. Information from the maps, nine tables of water-level correction factors, and the concurrent water levels at a test site and at an index observation well are used to estimate the high water level.

The technique assumes temporal and spatial continuity. It assumes that future precipitation, evaporation, and transpiration will be the same as in the past, and it assumes strong correlations between water-level fluctuations at septic-system sites and index wells. Water levels from the nine index-observation wells showed a high degree of correlation with the other 43 wells. Out of a possible 1.0, all of the pairs of wells used to revise the maps in this report had correlation coefficients of 0.8 or better, and more than 50 percent of the pairs of wells had coefficients of 0.9 or better. Statistical tests of the correlation coefficients and the number of pairs of measurements (student's t-test) showed all of the correlations to be significant at the 0.05 level.

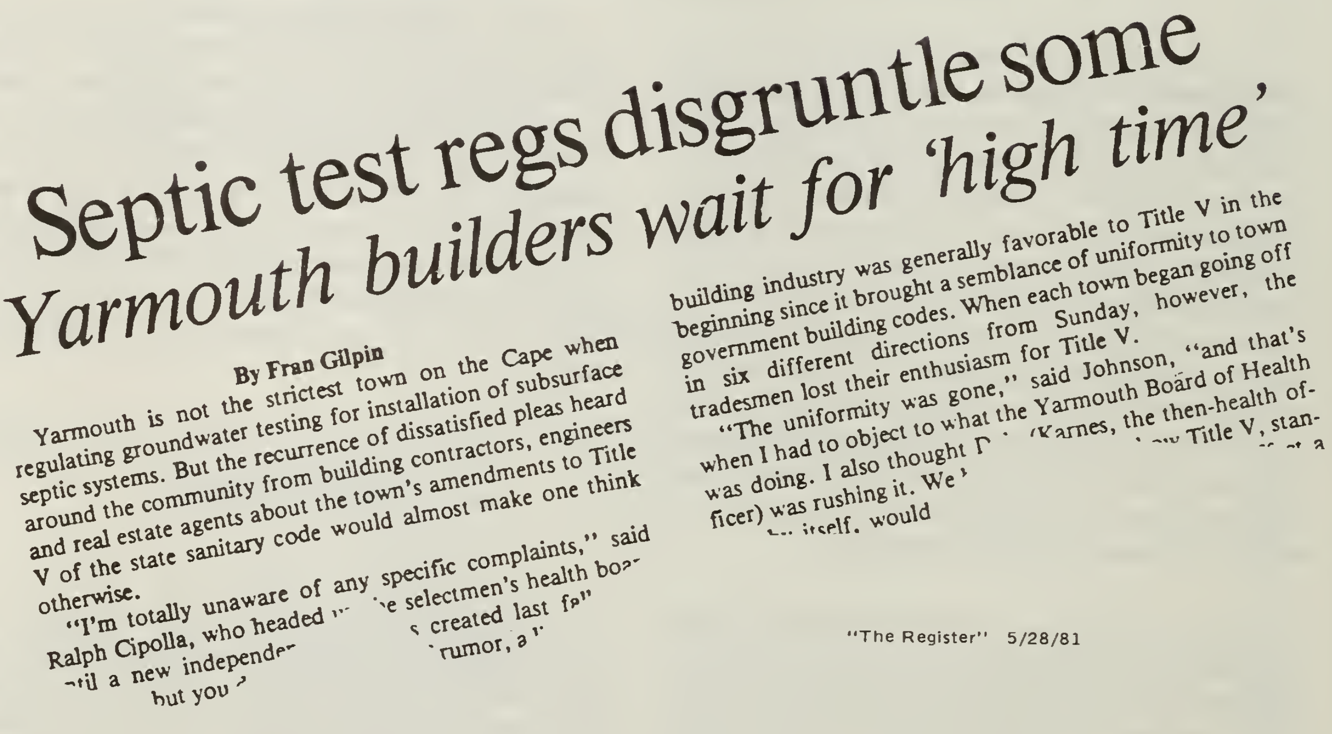
This report includes a demonstration of the application of the technique for estimation of high ground-water level, a design parameter needed for septic system regulation on Cape Cod. The technique can also be used at potential building construction sites and other places where estimates of highest ground-water levels are needed. This report is an update of the 1983 report, "Estimating highest ground-water levels for construction and land use planning--a Cape Cod example".

INTRODUCTION

High ground-water levels are a major cause of septic-system failures, wet basements, and other problems for suburban and rural residents. For example, unexpectedly high ground-water levels can flood septic systems, causing sewage to back up into the home, and (or) reach the land surface, threatening public health, creating obnoxious odors, and devaluating property (fig. 1). Persons who come in contact with untreated sewage can be exposed to bacterial and viral diseases, such as hepatitis, dysentery, cholera, and typhoid fever. Conditions leading to these problems can be anticipated during design phases of construction.



Photograph courtesy of Soil Conservation Service, U.S. Department of Agriculture



Septic test regs disgruntle some *Yarmouth builders wait for 'high time'*

By Fran Gilpin

Yarmouth is not the strictest town on the Cape when regulating groundwater testing for installation of subsurface septic systems. But the recurrence of dissatisfied pleas heard around the community from building contractors, engineers and real estate agents about the town's amendments to Title V of the state sanitary code would almost make one think otherwise.

"I'm totally unaware of any specific complaints," said Ralph Cipolla, who headed ... selectmen's health boa... created last fa... until a new independe... rumor, a... but you ...

building industry was generally favorable to Title V in the beginning since it brought a semblance of uniformity to town government building codes. When each town began going off in six different directions from Sunday, however, the tradesmen lost their enthusiasm for Title V.

"The uniformity was gone," said Johnson, "and that's when I had to object to what the Yarmouth Board of Health was doing. I also thought D... (Karnes, the then-health officer) was rushing it. We ... Title V, stan- ... itself, would

"The Register" 5/28/81

Figure 1.--Septic system breakout and newspaper article.

This report presents an estimation technique that could be employed, with certain adaptations, almost anywhere in the world that high ground-water levels in soil present problems with regard to construction. Practical applications of the technique are the design and safe use of septic-tank drainage pits, trenches, and fields, and the design of foundations, basements, and landscaping and drainage. The technique can be used in any season, thus eliminating the need to restrict water-level measurements to periods of high water level. It can, as an aid, help relieve builders, construction engineers, and health officials of seasonal restrictions on site testing.

The maps and tables in this report were updated from an earlier report (Frimpter and Fisher, 1983). Data in this report has been updated on the basis of measurements made from 52 short-term observation wells with 13 years of record, and 8 long-term observation wells having 28 to 36 years of record. The original report was based on 146 short-term observation wells having 1 year of record and 9 long-term wells having 16 to 28 years of record. Although the authors are unaware of any reports of septic system failures caused by the use of estimates made with the original report, the maps and tables in this updated report will allow estimation of high ground-water levels with improved accuracy. Index wells that best represent areas of southern Yarmouth, southern Barnstable, Mashpee, Falmouth, and Bourne differ from those used for the original report, but water-level ranges were not changed. Tables 1-9 have been expanded to include new extremes of water levels that occurred since the original reports were prepared and the need to calculate extensions of the tables is no longer necessary.

To avoid septic-system failure caused by high ground-water levels, the U.S. Department of Health, Education, and Welfare (1969) and the Commonwealth of Massachusetts Department of Environmental Quality Engineering (1977) have recommended that the bottoms of domestic septic systems be at least 4 feet above the maximum anticipated level of the water table. The aerated zone between the bottom of the leaching facility of the septic system and the water table acts as a safety zone against flooding and also allows physical, chemical, and microbial processes to convert the sewage constituents into less noxious forms. Accurate estimates of high ground-water levels are therefore, necessary for the construction of properly operating septic systems.

This report is the product of a cooperative study by the Cape Cod Commission and the U.S. Geological Survey.

Ground-water Fluctuation with Time and Location

Ground-water levels can fluctuate several feet in response to seasonal weather and conditions and hydrologic factors. A single water-level measurement, although easily obtained, will rarely represent extreme ground-water levels. During the summer months, when evaporation and transpiration rates are high, water levels decline, reaching their lowest levels in late fall (fig. 2). During the winter months, water levels rise and commonly reach their highest levels in March and April. Recognizing this seasonal variation in water levels, some public health agencies have previously required that water levels be measured only during late winter and early spring for septic-system permit applications.

Hydrologic factors, other than seasonal changes in evaporation and transpiration, cause fluctuations in ground-water level. Long periods of below-average or no precipitation (one definition of a drought), such as that in the mid-1960s may cause water levels to decline to several feet below normal. Above-average precipitation, such as occurred in the early 1970s, may cause water levels to rise higher than normal. Pumping of wells causes water levels to decline.

Hydrologic location also affects water-level range. Generally, the range is smallest near the ocean and near its bays, estuaries, or salt marshes. For example, the water level in obser-

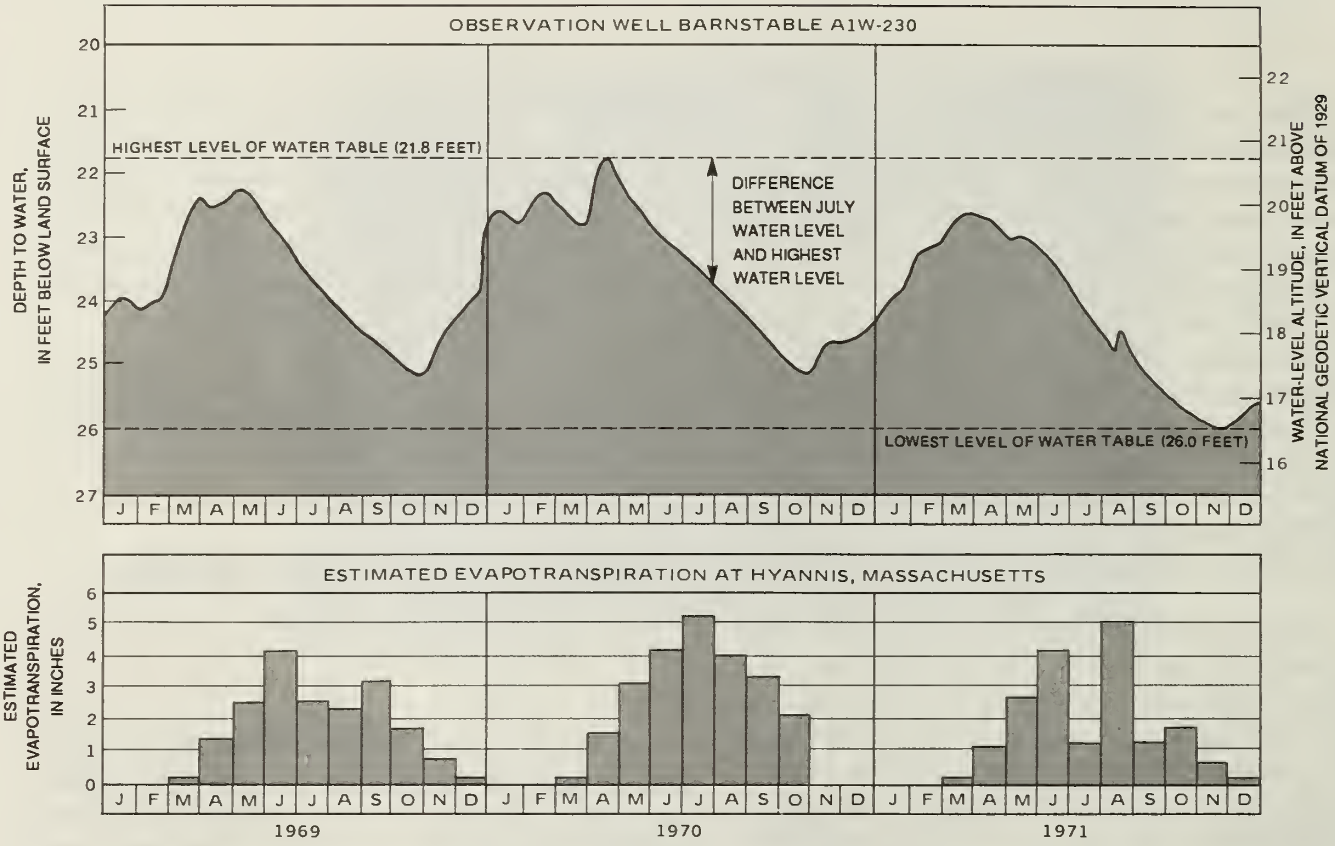


Figure 2.--Monthly water-level fluctuations in response to evapotranspiration.

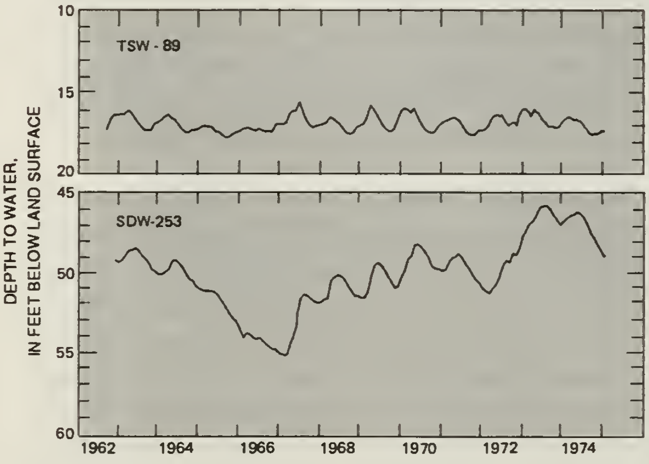


Figure 3.--Dissimilar water-level fluctuations in wells at 0.3 mile (TSW-89) and 6 miles (SDW-253) from Cape Cod Bay.

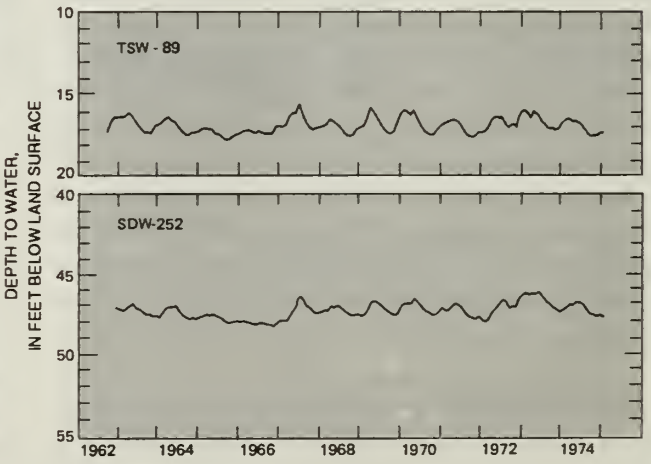


Figure 4.--Similar water-level fluctuations in two wells about 28 miles apart, but close to Cape Cod Bay.

vation well SDW-252 in Sandwich, 0.3 miles from Cape Cod Bay, fluctuated only 2.6 feet, while the water level in well SDW-253 in Sandwich, 6 miles inland from Cape Cod Bay, fluctuated 9.3 feet over the same 13-year period (figs. 3 and 4). However, tidal fluctuations can affect ground-water levels within about 300 feet of the shore.

Explanation of the Technique

The technique described in this report depends on several hydrologic characteristics of Cape Cod. First, weather and climate are relatively uniform throughout Cape Cod. Second, future weather and climatic conditions are assumed to be the same as in the past. This assumption is supported by no observable long-term trend in water levels in the observation-well network. Third, most of Cape Cod consists of sandy deposits that have relatively uniform hydrologic properties from site to site. This technique is designed to be used at sites underlain by sandy and gravelly soils, and not in wetlands or at sites where layers of clay, silt, or till are present.

Water-level ranges are generally not shown in wetlands, marshes, and water bodies on the maps (plates 1-4) in this report, because use of the technique in these areas would be inappropriate and lead to errors. In addition, the map delineations of the wetlands, marshes, and water bodies are too inaccurate for lot-by-lot assessments and should not be used to determine where the technique may or may not be applied. Field investigation to determine on-site soil and hydrologic conditions is needed for proper evaluation of the suitability of the site for application of the technique.

The Cape Cod Commission, Water Resources Office, in cooperation with the U.S. Geological Survey (USGS), maintains a network of 65 observation wells across the Cape. The water levels in these wells are measured on a monthly or bimonthly basis, and the data are maintained by both the Commission and the USGS in computer databases.

Water-level data for a 13-year period for 52 wells were used to determine five ranges (0-2 feet, 2-3 feet, 3-4 feet, 4-5 feet, and 5-6 feet) of annual fluctuations in ground-water levels (plates 1-4). Nine of the 52 observation wells were selected as index wells. Areas where water levels best correlate with each of the nine index-observation wells are delineated on the maps as dashed-line boundaries (plates 1-4). Since the initial reports on high water levels on Cape Cod were written in 1980 and 1983, additional data have since been collected and analyzed. Multiple-regression analyses of ground-water levels has resulted in selection of one new index-observation well, MIW-29 in Mashpee, and elimination of index well BHW-198 in Bourne for use with the estimating technique. Also, the areas represented by the index-observation wells have been revised. New water-level correction tables computed from the 1991 water-level records (longer than those in 1980) are included in this report. The tables are matrixes of water-level adjustments to be applied to water-level measurements from test sites. The similarity of water levels in two observation wells almost 30 miles apart on opposite sides of Cape Cod Bay is evidence of a high degree of correlation (fig. 4). Water levels from the nine index-observation wells showed a high degree of correlation with the other 43 wells. Out of a possible 1.0, all of the pairs of wells used to revise the maps in this report had correlation coefficients of 0.8 or better, and more than 50 percent of the pairs of wells had coefficients of 0.9 or better. Statistical tests of the correlation coefficients and the number of pairs of measurements (student's t-test) showed all of the correlations to be significant at the 0.05 level.

The water-level adjustment tables 1-4 and 6-9 are calculated from water-level records that span the periods of the highest (1972, 1987) and lowest (1965, 1981) annual precipitation recorded at Hyannis over a 96-year period (1894-1990). Table 5 for the new Mashpee index well is derived from water levels measured over 14 years (1976 and August 1978 through September

1991). A test of the technique using 49 wells showed that, over a 5-year period, water levels exceeded the estimated high-water level at only 8 percent of the wells, and all errors were less than 0.75 foot.

Sites near tidal water bodies present special problems. Within about 300 feet of tidal bodies, tides affect ground-water levels on Cape Cod. Where land elevations are close to sea level and the water table is shallow, tidal effects are superimposed on the seasonal fluctuations for which the technique in this report is designed. At a site affected by tides, estimates of high ground-water level may be made by first measuring the water-level fluctuation over 24 hours (12 hours during a full or new moon), and then subtracting one-half of that fluctuation from the depth to high-water level estimated by the technique.

The response of the ground-water level to tides is delayed for variable lengths of time, according to soil properties and distances between a site and the tidal water body. Because the amount of delay is not known in advance, two ground-water-level measurements, one made at high tide and the other at low tide, may not measure the full range of ground-water level caused by tides. Also, tidal magnitudes differ according to phase of the moon and and season, therefore selection of the measurement date can have an additional effect on the observed range in ground-water levels. For further information, "Tide tables (current year) high and low water predictions, East Coast of North America" can be purchased from National Ocean Service, Distribution, 6501 Lafayette Ave., Riverdale, MD 20840.

ESTIMATION OF HIGH GROUND-WATER LEVELS

Step 1. Measure Depth-to-Water at the Test Site

Measure the depth-to-water below the land surface (fig. 5) and record it on the computation form (fig. 6). Make measurement to the nearest 0.1 foot (fig. 5) and note soil conditions. For example, as recorded on the computation for Step 1 the depth-to-water was 10.8 feet on August 23, 1990. Sites should be inspected for the presence of buried layers of silt, clay, or till prior to attempting to estimate water levels. This technique is valid only in sandy and gravelly soil.

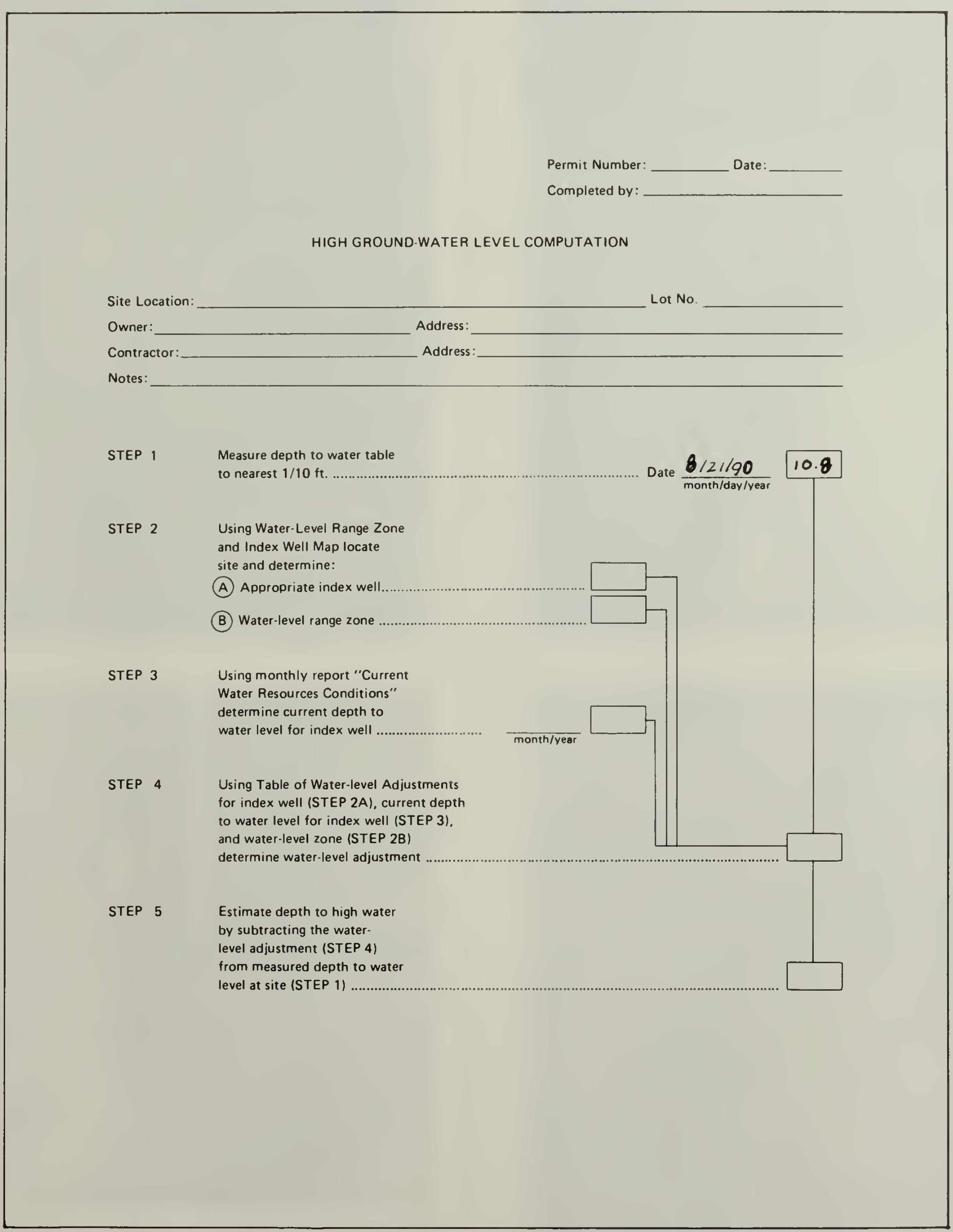
Step 2. Identify the Representative Index Well and Annual Water-Level-Range Zone for the Test Site.

Locate the test site on the "Annual Ranges of Ground-Water Level and Index-Well Areas for Cape Cod" maps (plates 1-4) accompanying this report. The location of the example test site is shown on plate 2.

Step 2A. Determine the Appropriate Index Well for the Site and Enter the Well Number on Computation Form (fig. 7).

Step 2B. Determine the Annual Water-Level Range Zone in which the Site is Located and Enter the Zone Letter on Computation Form (fig. 7).

On plate 2, the example test site is located in the area indexed to well MIW-29 and is in Water-Level-Range Zone B.



Permit Number: ________ Date: ________

Completed by: ____________________

HIGH GROUND-WATER LEVEL COMPUTATION

Site Location: ______________________________ Lot No. ________

Owner: ____________________ Address: ____________________

Contractor: ____________________ Address: ____________________

Notes: ____

STEP 1 Measure depth to water table to nearest 1/10 ft. .... Date 8/21/90 (month/day/year) 10.8

STEP 2 Using Water-Level Range Zone and Index Well Map locate site and determine:

Ⓐ Appropriate index well.................... ☐

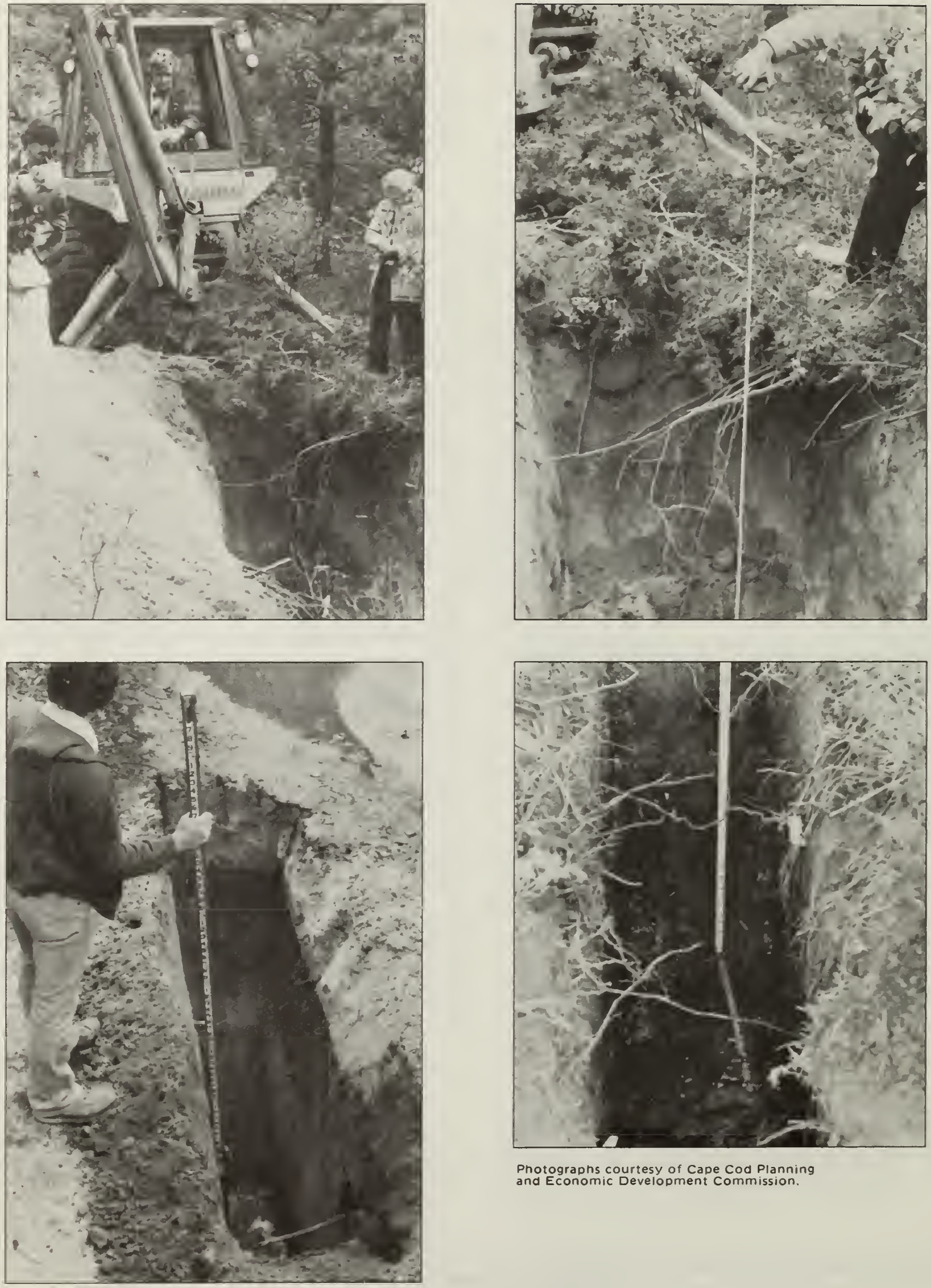
Ⓑ Water-level range zone .... ☐

STEP 3 Using monthly report "Current Water Resources Conditions" determine current depth to water level for index well .... ______ (month/year) ☐

STEP 4 Using Table of Water-level Adjustments for index well (STEP 2A), current depth to water level for index well (STEP 3), and water-level zone (STEP 2B) determine water-level adjustment .... ☐

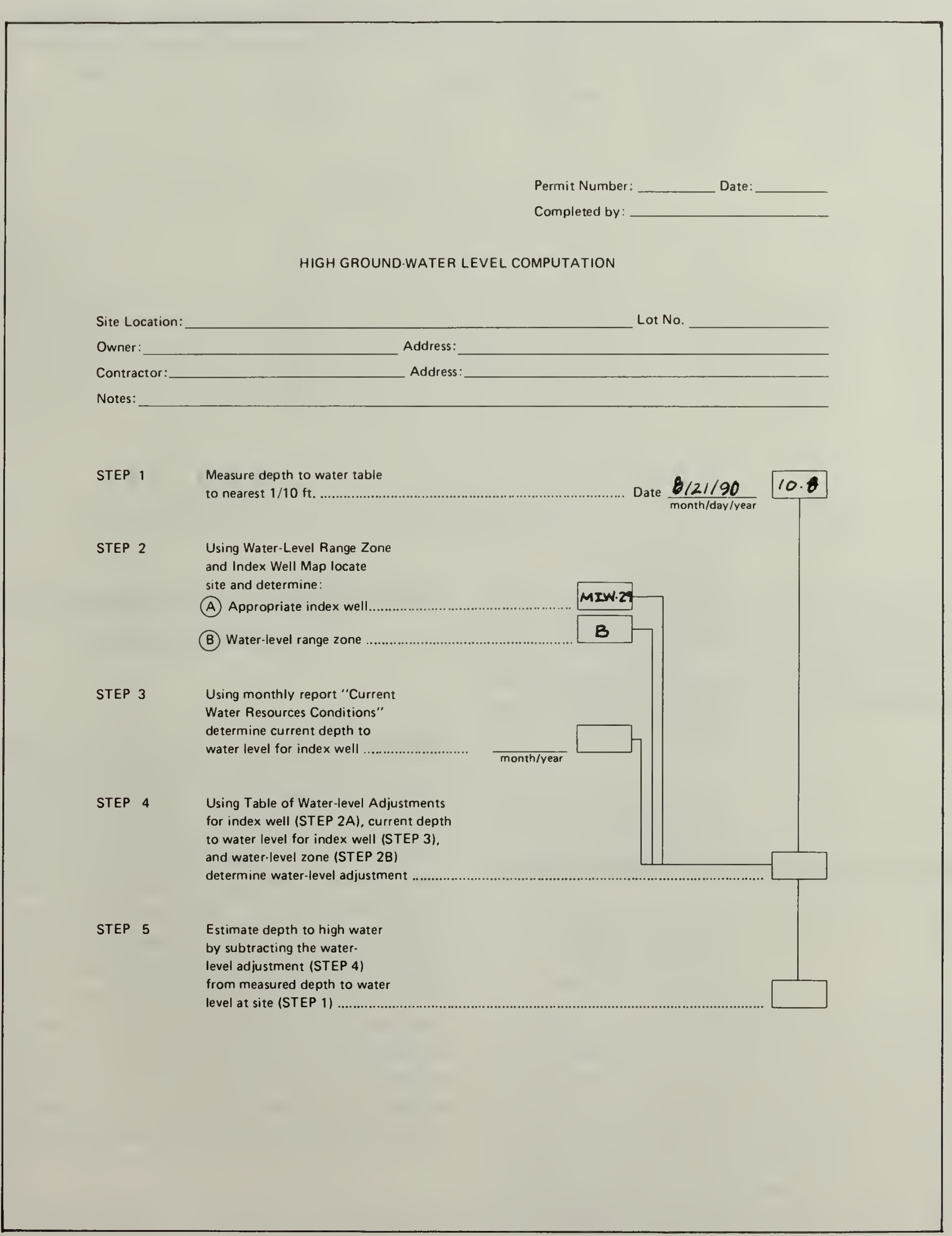
STEP 5 Estimate depth to high water by subtracting the water-level adjustment (STEP 4) from measured depth to water level at site (STEP 1) .... ☐

Figure 5.--Computation form, step 1.



Photographs courtesy of Cape Cod Planning and Economic Development Commission.

Figure 6.--Measuring depth to water.



Permit Number: __________ Date: __________

Completed by: ____________________

HIGH GROUND-WATER LEVEL COMPUTATION

Site Location: ____________________ Lot No. __________

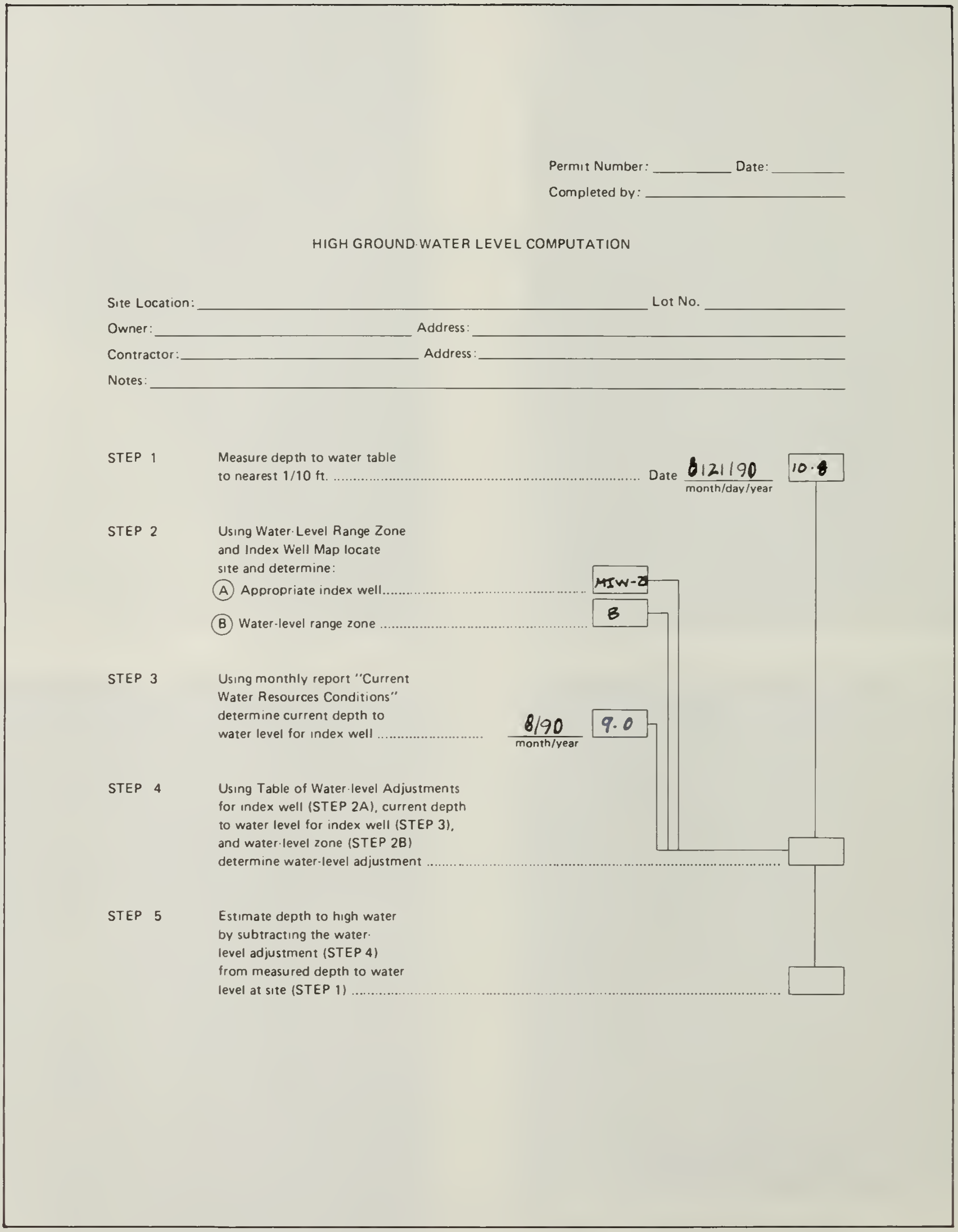
Owner: ____________________ Address: ____________________

Contractor: ____________________ Address: ____________________

Notes: ____________________

STEP 1	Measure depth to water table to nearest 1/10 ft. .... Date 8/21/90 (month/day/year)	10.8
STEP 2	Using Water-Level Range Zone and Index Well Map locate site and determine:	
	Ⓐ Appropriate index well	MIW-29
	Ⓑ Water-level range zone	B
STEP 3	Using monthly report "Current Water Resources Conditions" determine current depth to water level for index well .... ______ (month/year)	
STEP 4	Using Table of Water-level Adjustments for index well (STEP 2A), current depth to water level for index well (STEP 3), and water-level zone (STEP 2B) determine water-level adjustment	
STEP 5	Estimate depth to high water by subtracting the water-level adjustment (STEP 4) from measured depth to water level at site (STEP 1)	

Figure 7.--Computation form, Step 2.



Permit Number: __________ Date: __________

Completed by: ____________________

HIGH GROUND-WATER LEVEL COMPUTATION

Site Location: ____________________ Lot No. __________

Owner: ____________________ Address: ____________________

Contractor: ____________________ Address: ____________________

Notes: ____________________

STEP 1 Measure depth to water table to nearest 1/10 ft. .... Date 8/21/90 (month/day/year) 10.8

STEP 2 Using Water-Level Range Zone and Index Well Map locate site and determine:

Ⓐ Appropriate index well MIW-2

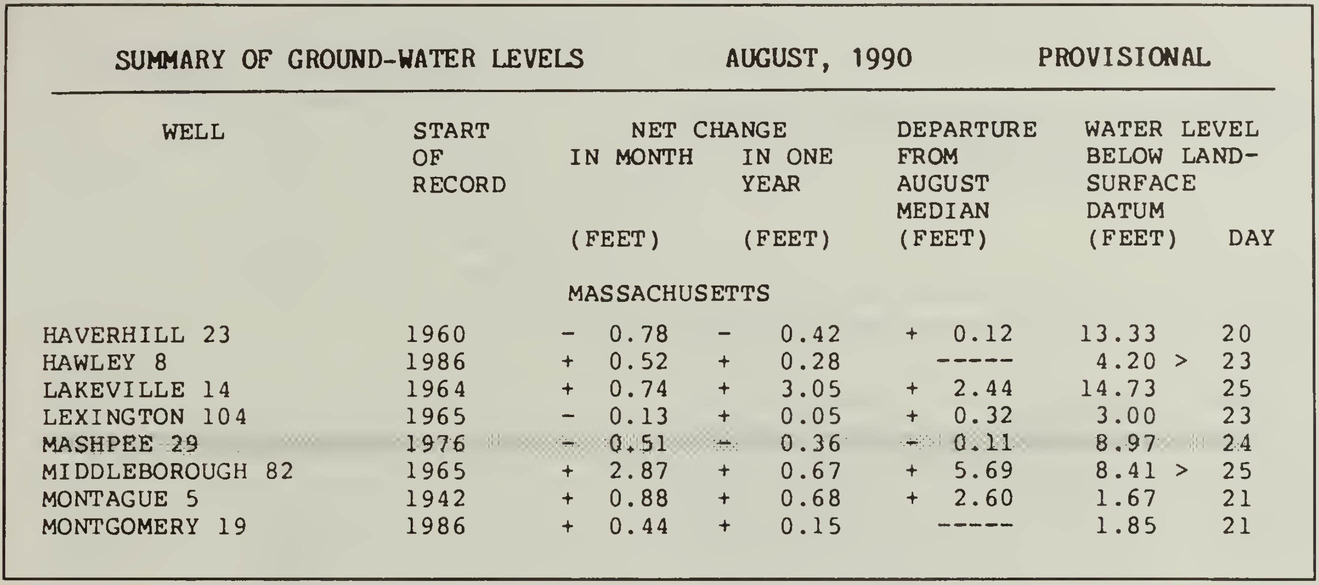
Ⓑ Water-level range zone .... B

STEP 3 Using monthly report "Current Water Resources Conditions" determine current depth to water level for index well .... 8/90 (month/year) 9.0

STEP 4 Using Table of Water-level Adjustments for index well (STEP 2A), current depth to water level for index well (STEP 3), and water-level zone (STEP 2B) determine water-level adjustment .... ☐

STEP 5 Estimate depth to high water by subtracting the water-level adjustment (STEP 4) from measured depth to water level at site (STEP 1) .... ☐

Figure 8.--Computation form, Step 3.



SUMMARY OF GROUND-WATER LEVELS AUGUST, 1990 PROVISIONAL

WELL	START OF RECORD	NET CHANGE IN MONTH (FEET)	NET CHANGE IN ONE YEAR (FEET)	DEPARTURE FROM AUGUST MEDIAN (FEET)	WATER LEVEL BELOW LAND-SURFACE DATUM (FEET)	DAY
		MASSACHUSETTS				
HAVERHILL 23	1960	- 0.78	- 0.42	+ 0.12	13.33	20
HAWLEY 8	1986	+ 0.52	+ 0.28	-----	4.20 >	23
LAKEVILLE 14	1964	+ 0.74	+ 3.05	+ 2.44	14.73	25
LEXINGTON 104	1965	- 0.13	+ 0.05	+ 0.32	3.00	23
MASHPEE 29	1976	- 0.51	- 0.36	+ 0.11	8.97	24
MIDDLEBOROUGH 82	1965	+ 2.87	+ 0.67	+ 5.69	8.41 >	25
MONTAGUE 5	1942	+ 0.88	+ 0.68	+ 2.60	1.67	21
MONTGOMERY 19	1986	+ 0.44	+ 0.15	-----	1.85	21

Figure 9.--Sample excerpt from "Current Water Resources Conditions in Central New England".

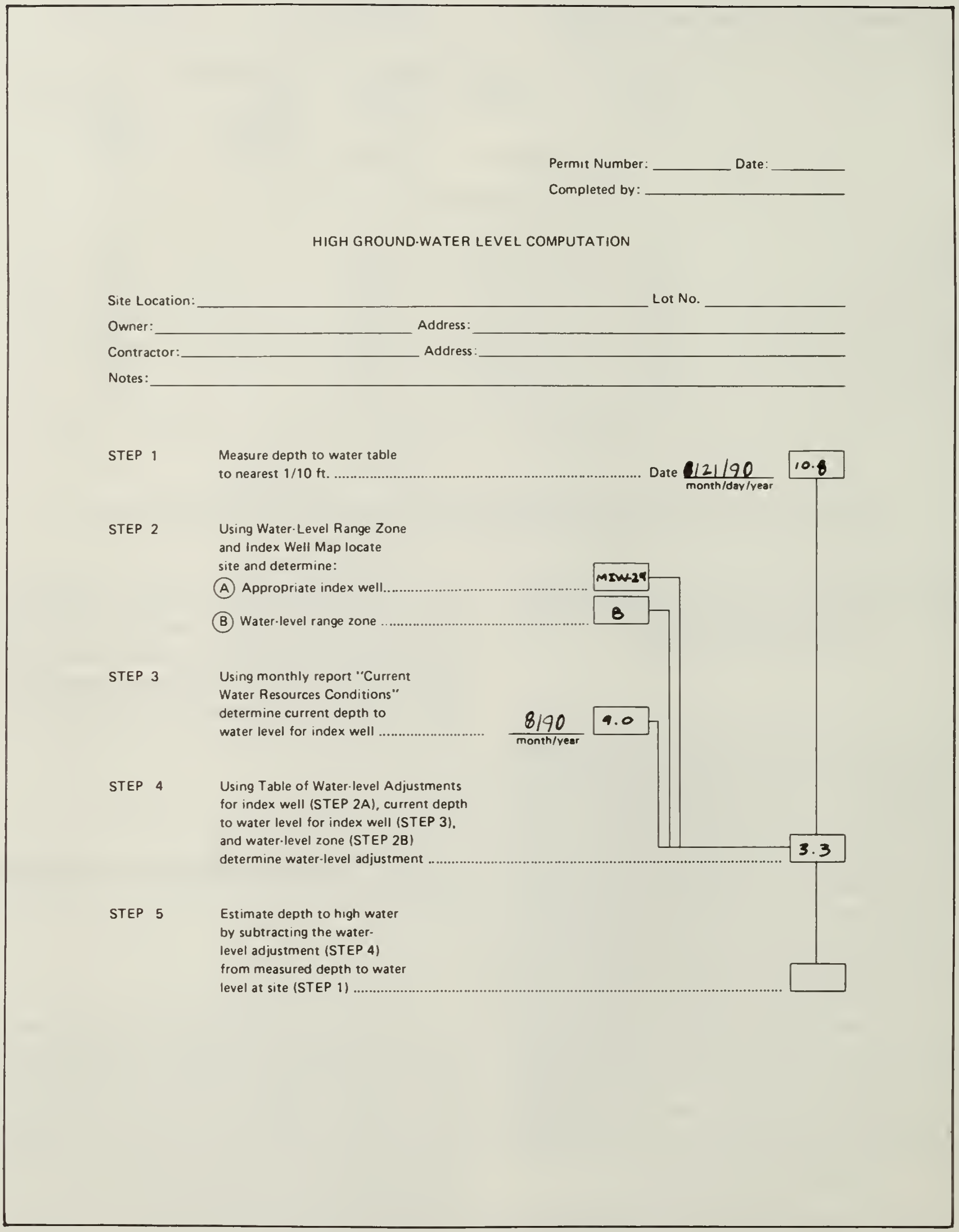
Step 3. Determine Current Depth-to-Water Level for Index Well

Determine the depth-to-water for the index well identified in Step 2A using the Summary of Ground-Water Levels Table from the USGS monthly report "Current Water Resources Conditions in Central New England" (fig. 8) or the Cape Cod Commission bimonthly newsletter " The Commission Reporter." Select the level for the end-of-month closest in time to the date of the water-level measurement at the test site. Record that water level and the date at the Step 3 level on the computation form (fig. 9). For example, the index well recorded in Step 2A was Mashpee 29 (MIW-29), and the monthly report for August 1990 shows that the depth to water for Mashpee 29 was 8.97 feet below land surface (9.0 feet when rounded to the nearest tenth of a foot).

"Current Water Resources Conditions in Central New England" is available from the U.S. Geological Survey, 28 Lord Road, Suite 280, Marlborough, MA 01752. "The Commission Reporter" is available from the Cape Cod Commission, 3225 Main Street, Barnstable, MA 02630. Note that the USGS monthly report omits the 3-character alpha-numeric prefix from the index well identifiers, but tables 1-9 in this report cross reference the town names with the 3-character prefixes of the index well identifiers. For example, Barnstable 230 is also A1W-230 in table 1.

Step 4. Determine Water-Level Adjustment

Refer to the water-level-adjustment table, "Potential Water-Level Rise, in feet, for Use With Index Well...", (tables 1-9 in the back of this report) for the appropriate index well (recorded in Step 2A). Record the water-level-adjustment value on the computation form (fig. 10). To determine the correct water-level adjustment, locate the current water level for the index well in the left-hand column of the water-level adjustment table (fig. 11). Then read from left to right on the same horizontal row to the column of adjustment values for the zone recorded in Step 2B. Figure 11 shows the water-level adjustment for the example test site is 3.3 feet.



Permit Number: __________ Date: __________

Completed by: ____________________

HIGH GROUND-WATER LEVEL COMPUTATION

Site Location: ____________________ Lot No. __________

Owner: ____________________ Address: ____________________

Contractor: ____________________ Address: ____________________

Notes: ____________________

STEP 1 Measure depth to water table to nearest 1/10 ft. .... Date 8/21/90 (month/day/year) 10.8

STEP 2 Using Water-Level Range Zone and Index Well Map locate site and determine:

Ⓐ Appropriate index well.................... MIW-29

Ⓑ Water-level range zone .... B

STEP 3 Using monthly report "Current Water Resources Conditions" determine current depth to water level for index well .... 8/90 (month/year) 9.0

STEP 4 Using Table of Water-level Adjustments for index well (STEP 2A), current depth to water level for index well (STEP 3), and water-level zone (STEP 2B) determine water-level adjustment 3.3

STEP 5 Estimate depth to high water by subtracting the water-level adjustment (STEP 4) from measured depth to water level at site (STEP 1) .... ☐

Figure 10.--Computation form, Step 4.

Table 5. Potential water-level rise, in feet, for use with index well Mashpee MIW-29

WATER LEVEL	ZONE A	ZONE B	ZONE C
5.7	0	0.0	0.0
5.8	0.1	0.1	0.1
5.9	0.1	0.2	0.3
6.0	0.2	0.3	0.4
6.1	0.3	0.4	0.5
6.2	0.3	0.5	0.7
6.3	0.4	0.6	0.8
6.4	0.5	0.7	0.9
6.5	0.5	0.8	1.1
6.6	0.6	0.9	1.2
6.7	0.7	1.0	1.3
6.8	0.7	1.1	1.5
6.9	0.8	1.2	1.6
7.0	0.9	1.3	1.7
7.1	0.9	1.4	1.9
7.2	1.0	1.5	2.0
7.3	1.1	1.6	2.1
7.4	1.1	1.7	2.3
7.5	1.2	1.8	2.4
7.6	1.3	1.9	2.5
7.7	1.3	2.0	2.7
7.8	1.4	2.1	2.8
7.9	1.5	2.2	2.9
8.0	1.5	2.3	3.1
8.1	1.6	2.4	3.2
8.2	1.7	2.5	3.3
8.3	1.7	2.6	3.5
8.4	1.8	2.7	3.6
8.5	1.9	2.8	3.7
8.6	1.9	2.9	3.9
8.7	2.0	3.0	4.0
8.8	2.1	3.1	4.1
8.9	2.1	3.2	4.3
9.0	2.2	3.3	4.4
9.1	2.3	3.4	4.5
9.2	2.3	3.5	4.7
9.3	2.4	3.6	4.8
9.4	2.5	3.7	4.9
9.5	2.5	3.8	5.1
9.6	2.6	3.9	5.2
9.7	2.7	4.0	5.3
9.8	2.7	4.1	5.5
9.9	2.8	4.2	5.6
10.0	2.9	4.3	5.7
10.1	2.9	4.4	5.9
10.2	3.0	4.5	6.0
10.3	3.1	4.6	6.1
10.4	3.1	4.7	6.3
10.5	3.2	4.8	6.4
10.6	3.3	4.9	6.5

Figure 11.--Example of water-level adjustment table. (Excerpt from table 5 in appendix.)

Step 5. Estimate Depth-to-High-Water Level at Test Site

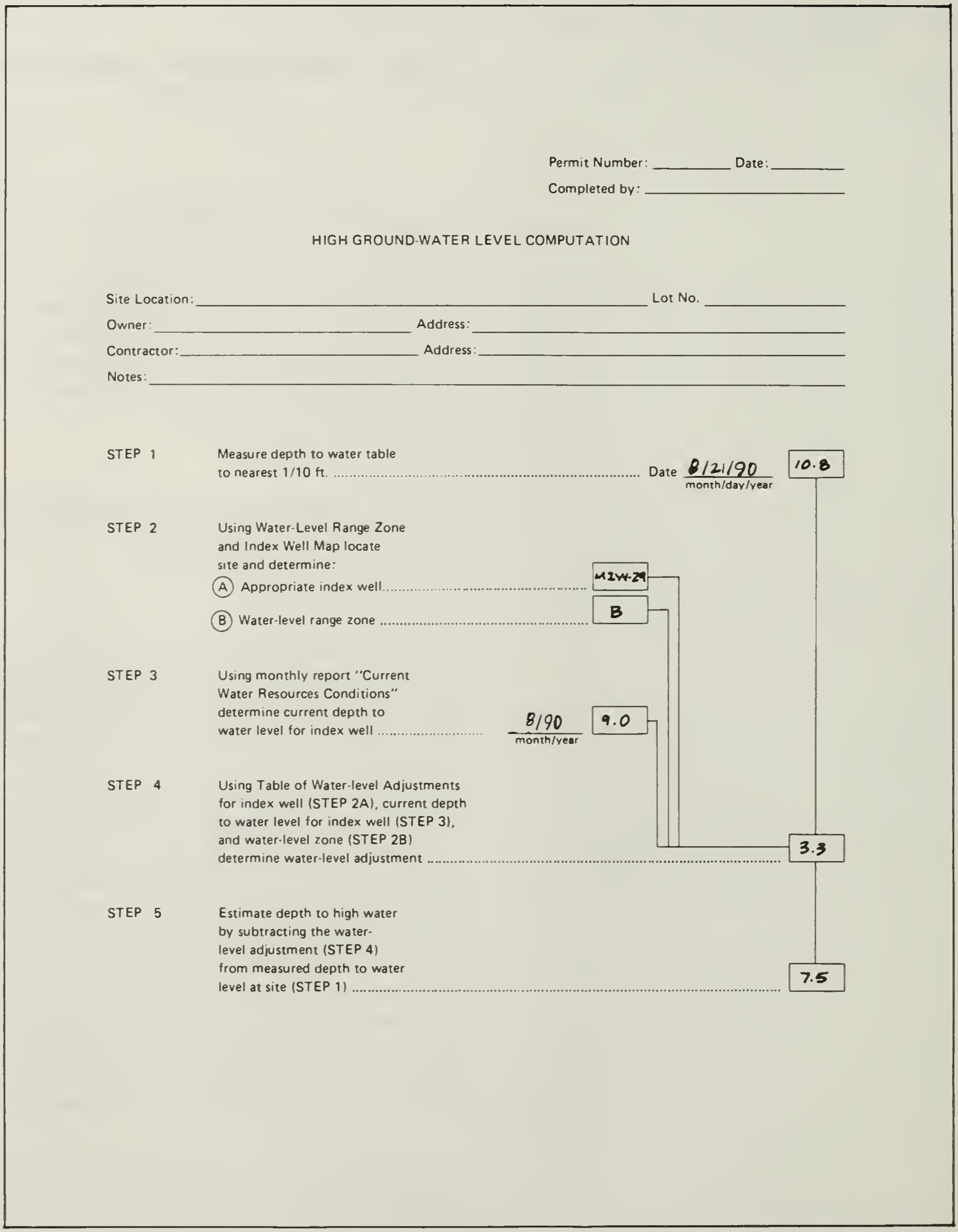
Using the computation form (fig. 12), subtract the water-level-adjustment value determined in Step 4 from the measured depth-to-water at the site recorded in Step 1 to obtain the estimate of depth-to-high-water level and record on the computation form (fig. 12). Figure 12 shows that the estimated depth-to-high-water level at the example test site is 7.5 feet below the land surface.

APPLICATION OF THE TECHNIQUE ON CAPE COD

The estimating technique described in this report has been widely used on Cape Cod for the past decade. According to the State of Massachusetts Sanitary Code (Title 5), and before the development of the technique, ground-water elevations for design and regulation of septic systems had to be measured when ground water was at its maximum elevation. In an attempt to conform to this regulation, some local Borards of Health restricted testing to the months of March, April, and May, the period of seasonal high ground-water levels. However, homebuilders found this restriction to be an impediment to efficient planning and scheduling of construction, while engineers and health officials found it to be inaccurate because springtime high water levels can vary significantly from year to year.

Another method of determining high ground-water levels is from soil color changes (mottling) that can be observed at the depth of the high water table in excavations in some soil types. Soil mottling, however, is not easily detected in many coarse-grained sediments, such as commonly occur on Cape Cod.

Most of the 15 towns of Cape Cod have incorporated the use of the technique in regulations



Permit Number: __________ Date: __________

Completed by: __________

HIGH GROUND-WATER LEVEL COMPUTATION

Site Location: __________ Lot No. __________

Owner: __________ Address: __________

Contractor: __________ Address: __________

Notes: __________

STEP 1 Measure depth to water table to nearest 1/10 ft. .... Date 8/21/90 (month/day/year) 10.8

STEP 2 Using Water-Level Range Zone and Index Well Map locate site and determine:

Ⓐ Appropriate index well M2W-29

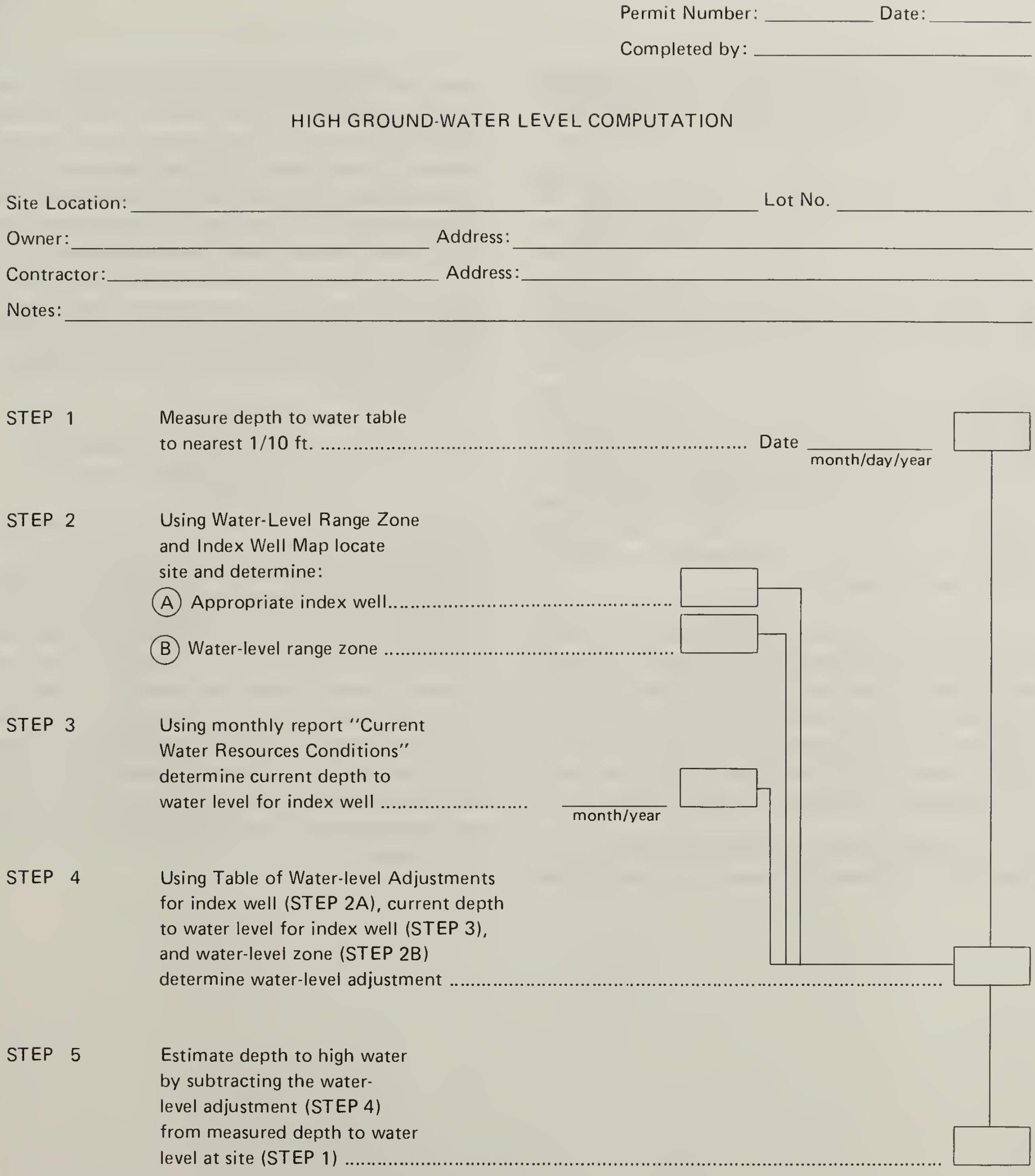
Ⓑ Water-level range zone .... B

STEP 3 Using monthly report "Current Water Resources Conditions" determine current depth to water level for index well .... 8/90 (month/year) 9.0

STEP 4 Using Table of Water-level Adjustments for index well (STEP 2A), current depth to water level for index well (STEP 3), and water-level zone (STEP 2B) determine water-level adjustment 3.3

STEP 5 Estimate depth to high water by subtracting the water-level adjustment (STEP 4) from measured depth to water level at site (STEP 1) 7.5

Figure 12.--Computation form, Step 5.



Permit Number: __________ Date: __________

Completed by: ______________________

HIGH GROUND-WATER LEVEL COMPUTATION

Site Location: ______________________ Lot No. __________

Owner: ______________ Address: ______________________

Contractor: ______________ Address: ______________________

Notes: ______________________________________

STEP 1 Measure depth to water table to nearest 1/10 ft. .... Date __________ month/day/year ☐

STEP 2 Using Water-Level Range Zone and Index Well Map locate site and determine:

Ⓐ Appropriate index well.............. ☐

Ⓑ Water-level range zone .... ☐

STEP 3 Using monthly report "Current Water Resources Conditions" determine current depth to water level for index well .... __________ month/year ☐

STEP 4 Using Table of Water-level Adjustments for index well (STEP 2A), current depth to water level for index well (STEP 3), and water-level zone (STEP 2B) determine water-level adjustment .... ☐

STEP 5 Estimate depth to high water by subtracting the water-level adjustment (STEP 4) from measured depth to water level at site (STEP 1) .... ☐

Figure 13.--Reproducible computation form.

for septic system installations. The regulations are made under the authority of Section 31, of Chapter 111, of the General Laws of the Commonwealth of Massachusetts. Virtually every practicing engineer on Cape Cod incorporates the technique when preparing plans for septic-system installation regardless of town regulation. In 1991, the Cape Cod Commission distributed water-level data for all of the index wells to more than 120 engineers, land surveyors, consultants, water superintendents and others conducting business on Cape Cod. Approximately 10-20 additional calls are received each month at the Commission office with requests for water-level information. In enforcing the legislation, if there is a disagreement with the application of the method, or its results, it is up to the project proponent's engineer to substantiate a different high water-level estimate.

Specific towns that include the USGS high-ground-water technique as a Board of Health regulation and the dates of its enactment by the towns are: Barnstable, 1981; Brewster, 1986; Mashpee, 1981; Yarmouth, pre-1981; Bourne, 1988; Dennis, 1989; Eastham, 1989; Sandwich, 1991; Harwich, 1989; and Chatham, 1992.

The USGS publishes the index-well data for Cape Cod in a monthly report, "Current Water Resources Conditions in Central New England" that is available free of charge, upon request. The USGS also publishes annual summaries and graphs of these data in "Water Resources Data, Massachusetts and Rhode Island, Water Year (current year)". These reports include surface- and ground-water levels for selected sites and provide some summary statistics on the observed data. The Cape Cod Commission also publishes the index-well data in their bimonthly newsletter "The Commission Reporter", which is available by subscription.

SUMMARY

High ground-water levels can be estimated for sand and gravel soils of Cape Cod by using the technique outlined in this report. An estimate can be made on the basis of one water-level measurement made during any season. This technique only applies to sand and gravel deposits and should not be applied to wetlands or in areas underlain by silt, clay, or till layers. Information and assistance needed to apply the technique are available from both the USGS and the Cape Cod Commission.

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TABLES OF POTENTIAL WATER-LEVEL RISE

Table 1. *Potential water-level rise, in feet, for use with index well Barnstable A1W-230*

WATER LEVEL	ZONE A	ZONE B	ZONE C	ZONE D	ZONE E
20.5	0.0	0.0	0.0	0.0	0.0
20.6	0.1	0.1	0.1	0.1	0.2
20.7	0.1	0.1	0.2	0.3	0.3
20.8	0.2	0.2	0.3	0.4	0.5
20.9	0.2	0.3	0.4	0.5	0.6
21.0	0.3	0.3	0.5	0.7	0.8
21.1	0.3	0.4	0.6	0.8	0.9
21.2	0.4	0.5	0.7	0.9	1.1
21.3	0.4	0.5	0.8	1.1	1.2
21.4	0.5	0.6	0.9	1.2	1.4
21.5	0.5	0.7	1.0	1.3	1.5
21.6	0.6	0.7	1.1	1.5	1.7
21.7	0.6	0.8	1.2	1.6	1.8
21.8	0.7	0.9	1.3	1.7	2.0
21.9	0.7	0.9	1.4	1.9	2.1
22.0	0.8	1.0	1.5	2.0	2.3
22.1	0.8	1.1	1.6	2.1	2.4
22.2	0.9	1.1	1.7	2.3	2.6
22.3	0.9	1.2	1.8	2.4	2.7
22.4	1.0	1.3	1.9	2.5	2.9
22.5	1.0	1.3	2.0	2.7	3.0
22.6	1.1	1.4	2.1	2.8	3.2
22.7	1.1	1.5	2.2	2.9	3.3
22.8	1.2	1.5	2.3	3.1	3.5
22.9	1.2	1.6	2.4	3.2	3.6
23.0	1.3	1.7	2.5	3.3	3.8
23.1	1.3	1.7	2.6	3.5	3.9
23.2	1.4	1.8	2.7	3.6	4.1
23.3	1.4	1.9	2.8	3.7	4.2
23.4	1.5	1.9	2.9	3.9	4.4
23.5	1.5	2.0	3.0	4.0	4.5
23.6	1.6	2.1	3.1	4.1	4.7
23.7	1.6	2.1	3.2	4.3	4.8
23.8	1.7	2.2	3.3	4.4	5.0
23.9	1.7	2.3	3.4	4.5	5.1
24.0	1.8	2.3	3.5	4.7	5.3
24.1	1.8	2.4	3.6	4.8	5.4
24.2	1.9	2.5	3.7	4.9	5.6
24.3	1.9	2.5	3.8	5.1	5.7
24.4	2.0	2.6	3.9	5.2	5.9
24.5	2.0	2.7	4.0	5.3	6.0
24.6	2.1	2.7	4.1	5.5	6.2
24.7	2.1	2.8	4.2	5.6	6.3
24.8	2.2	2.9	4.3	5.7	6.5
24.9	2.2	2.9	4.4	5.9	6.6
25.0	2.3	3.0	4.5	6.0	6.8
25.1	2.3	3.1	4.6	6.1	6.9
25.2	2.4	3.1	4.7	6.3	7.1
25.3	2.4	3.2	4.8	6.4	7.2
25.4	2.5	3.3	4.9	6.5	7.4
25.5	2.5	3.3	5.0	6.7	7.5
25.6	2.6	3.4	5.1	6.8	7.7
25.7	2.6	3.5	5.2	6.9	7.8
25.8	2.7	3.5	5.3	7.1	8.0
25.9	2.7	3.6	5.4	7.2	8.1

Table 1. *Potential water-level rise, in feet, for use with index well Barnstable A1W-230*--Continued

WATER LEVEL	ZONE A	ZONE B	ZONE C	ZONE D	ZONE E
26.0	2.8	3.7	5.5	7.3	8.3
26.1	2.8	3.7	5.6	7.5	8.4
26.2	2.9	3.8	5.7	7.6	8.6
26.3	2.9	3.9	5.8	7.7	8.7
26.4	3.0	3.9	5.9	7.9	8.9
26.5	3.0	4.0	6.0	8.0	9.0
26.6	3.1	4.1	6.1	8.1	9.2
26.7	3.1	4.1	6.2	8.3	9.3
26.8	3.2	4.2	6.3	8.4	9.5
26.9	3.2	4.3	6.4	8.5	9.6
27.0	3.3	4.3	6.5	8.7	9.8
27.1	3.3	4.4	6.6	8.8	9.9
27.2	3.4	4.5	6.7	8.9	10.1
27.3	3.4	4.5	6.8	9.1	10.2
27.4	3.5	4.6	6.9	9.2	10.4
27.5	3.5	4.7	7.0	9.3	10.5
27.6	3.6	4.7	7.1	9.5	10.7
27.7	3.6	4.8	7.2	9.6	10.8
27.8	3.7	4.9	7.3	9.7	11.0
27.9	3.7	4.9	7.4	9.9	11.1
28.0	3.8	5.0	7.5	10.0	11.3
28.1	3.8	5.1	7.6	10.1	11.4
28.2	3.9	5.1	7.7	10.3	11.6
28.3	3.9	5.2	7.8	10.4	11.7
28.4	4.0	5.3	7.9	10.5	11.9
28.5	4.0	5.3	8.0	10.7	12.0
28.6	4.1	5.4	8.1	10.8	12.2
28.7	4.1	5.5	8.2	10.9	12.3
28.8	4.2	5.5	8.3	11.1	12.5
28.9	4.2	5.6	8.4	11.2	12.6
29.0	4.3	5.7	8.5	11.3	12.8
29.1	4.3	5.7	8.6	11.5	12.9
29.2	4.4	5.8	8.7	11.6	13.1
29.3	4.4	5.9	8.8	11.7	13.2
29.4	4.5	5.9	8.9	11.9	13.4
29.5	4.5	6.0	9.0	12.0	13.5
29.6	4.6	6.1	9.1	12.1	13.7
29.7	4.6	6.1	9.2	12.3	13.8
29.8	4.7	6.2	9.3	12.4	14.0
29.9	4.7	6.3	9.4	12.5	14.1
30.0	4.8	6.3	9.5	12.7	14.3
30.1	4.8	6.4	9.6	12.8	14.4
30.2	4.9	6.5	9.7	12.9	14.6
30.3	4.9	6.5	9.8	13.1	14.7
30.4	5.0	6.6	9.9	13.2	14.9
30.5	5.0	6.7	10.0	13.3	15.0
30.6	5.1	6.7	10.1	13.5	15.2
30.7	5.1	6.8	10.2	13.6	15.3
30.8	5.2	6.9	10.3	13.7	15.5
30.9	5.2	6.9	10.4	13.9	15.6
31.0	5.3	7.0	10.5	14.0	15.8
31.1	5.3	7.1	10.6	14.1	15.9
31.2	5.4	7.1	10.7	14.3	16.1
31.3	5.4	7.2	10.8	14.4	16.2
31.4	5.5	7.3	10.9	14.5	16.4

Table 2. *Potential water-level rise, in feet, for use with index well Barnstable A1W-247*

WATER LEVEL	ZONE A	ZONE B	ZONE C	ZONE D
20.7	0.0	0.0	0.0	0.0
20.8	0.1	0.1	0.1	0.2
20.9	0.1	0.2	0.3	0.3
21.0	0.2	0.3	0.4	0.5
21.1	0.3	0.4	0.5	0.7
21.2	0.3	0.5	0.7	0.8
21.3	0.4	0.6	0.8	1.0
21.4	0.5	0.7	0.9	1.2
21.5	0.5	0.8	1.1	1.3
21.6	0.6	0.9	1.2	1.5
21.7	0.7	1.0	1.3	1.7
21.8	0.7	1.1	1.5	1.8
21.9	0.8	1.2	1.6	2.0
22.0	0.9	1.3	1.7	2.2
22.1	0.9	1.4	1.9	2.3
22.2	1.0	1.5	2.0	2.5
22.3	1.1	1.6	2.1	2.7
22.4	1.1	1.7	2.3	2.8
22.5	1.2	1.8	2.4	3.0
22.6	1.3	1.9	2.5	3.2
22.7	1.3	2.0	2.7	3.3
22.8	1.4	2.1	2.8	3.5
22.9	1.5	2.2	2.9	3.7
23.0	1.5	2.3	3.1	3.8
23.1	1.6	2.4	3.2	4.0
23.2	1.7	2.5	3.3	4.2
23.3	1.7	2.6	3.5	4.3
23.4	1.8	2.7	3.6	4.5
23.5	1.9	2.8	3.7	4.7
23.6	1.9	2.9	3.9	4.8
23.7	2.0	3.0	4.0	5.0
23.8	2.1	3.1	4.1	5.2
23.9	2.1	3.2	4.3	5.3
24.0	2.2	3.3	4.4	5.5
24.1	2.3	3.4	4.5	5.7
24.2	2.3	3.5	4.7	5.8
24.3	2.4	3.6	4.8	6.0
24.4	2.5	3.7	4.9	6.2
24.5	2.5	3.8	5.1	6.3
24.6	2.6	3.9	5.2	6.5
24.7	2.7	4.0	5.3	6.7
24.8	2.7	4.1	5.5	6.8
24.9	2.8	4.2	5.6	7.0
25.0	2.9	4.3	5.7	7.2
25.1	2.9	4.4	5.9	7.3
25.2	3.0	4.5	6.0	7.5
25.3	3.1	4.6	6.1	7.7
25.4	3.1	4.7	6.3	7.8
25.5	3.2	4.8	6.4	8.0
25.6	3.3	4.9	6.5	8.2
25.7	3.3	5.0	6.7	8.3
25.8	3.4	5.1	6.8	8.5
25.9	3.5	5.2	6.9	8.7
26.0	3.5	5.3	7.1	8.8
26.1	3.6	5.4	7.2	9.0
26.2	3.7	5.5	7.3	9.2
26.3	3.7	5.6	7.5	9.3
26.4	3.8	5.7	7.6	9.5
26.5	3.9	5.8	7.7	9.7
26.6	3.9	5.9	7.9	9.8
26.7	4.0	6.0	8.0	10.0
26.8	4.1	6.1	8.1	10.2
26.9	4.1	6.2	8.3	10.3
27.0	4.2	6.3	8.4	10.5
27.1	4.3	6.4	8.5	10.7
27.2	4.3	6.5	8.7	10.8
27.3	4.4	6.6	8.8	11.0
27.4	4.5	6.7	8.9	11.2
27.5	4.5	6.8	9.1	11.3
27.6	4.6	6.9	9.2	11.5
27.7	4.7	7.0	9.3	11.7
27.8	4.7	7.1	9.5	11.8
27.9	4.8	7.2	9.6	12.0
28.0	4.9	7.3	9.7	12.2
28.1	4.9	7.4	9.9	12.3
28.2	5.0	7.5	10.0	12.5
28.3	5.1	7.6	10.1	12.7
28.4	5.1	7.7	10.3	12.8
28.5	5.2	7.8	10.4	13.0
28.6	5.3	7.9	10.5	13.2
28.7	5.3	8.0	10.7	13.3
28.8	5.4	8.1	10.8	13.5
28.9	5.5	8.2	10.9	13.7
29.0	5.5	8.3	11.1	13.8
29.1	5.6	8.4	11.2	14.0
29.2	5.7	8.5	11.3	14.2
29.3	5.7	8.6	11.5	14.3
29.4	5.8	8.7	11.6	14.5
29.5	5.9	8.8	11.7	14.7
29.6	5.9	8.9	11.9	14.8
29.7	6.0	9.0	12.0	15.0
29.8	6.1	9.1	12.1	15.2
29.9	6.1	9.2	12.3	15.3
30.0	6.2	9.3	12.4	15.5
30.1	6.3	9.4	12.5	15.7
30.2	6.3	9.5	12.7	15.8
30.3	6.4	9.6	12.8	16.0
30.4	6.5	9.7	12.9	16.2
30.5	6.5	9.8	13.1	16.3
30.6	6.6	9.9	13.2	16.5

Table 2. *Potential water-level rise, in feet, for use with index well Barnstable A1W-247*--Continued

WATER LEVEL	ZONE A	ZONE B	ZONE C	ZONE D
30.7	6.7	10.0	13.3	16.7
30.8	6.7	10.1	13.5	16.8
30.9	6.8	10.2	13.6	17.0
31.0	6.9	10.3	13.7	17.2
31.1	6.9	10.4	13.9	17.3
31.2	7.0	10.5	14.0	17.5
31.3	7.1	10.6	14.1	17.7
31.4	7.1	10.7	14.3	17.8
31.5	7.2	10.8	14.4	18.0
31.6	7.3	10.9	14.5	18.2
31.7	7.3	11.0	14.7	18.3
31.8	7.4	11.1	14.8	18.5
31.9	7.5	11.2	14.9	18.7
32.0	7.5	11.3	15.1	18.8
32.1	7.6	11.4	15.2	19.0
32.2	7.7	11.5	15.3	19.2
32.3	7.7	11.6	15.5	19.3
32.4	7.8	11.7	15.6	19.5
32.5	7.9	11.8	15.7	19.7
32.6	7.9	11.9	15.9	19.8
32.7	8.0	12.0	16.0	20.0
32.8	8.1	12.1	16.1	20.2
32.9	8.1	12.2	16.3	20.3
33.0	8.2	12.3	16.4	20.5
33.1	8.3	12.4	16.5	20.7
33.2	8.3	12.5	16.7	20.8
33.3	8.4	12.6	16.8	21.0
33.4	8.5	12.7	16.9	21.2
33.5	8.5	12.8	17.1	21.3
33.6	8.6	12.9	17.2	21.5

Table 3. *Potential water-level rise, in feet, for use with index well Brewster BMW-21*

WATER	ZONE A	ZONE B
6.9	0.0	0.0
7.0	0.1	0.1
7.1	0.1	0.2
7.2	0.2	0.3
7.3	0.3	0.4
7.4	0.3	0.5
7.5	0.4	0.6
7.6	0.5	0.7
7.7	0.5	0.8
7.8	0.6	0.9
7.9	0.7	1.0
8.0	0.7	1.1
8.1	0.8	1.2
8.2	0.9	1.3
8.3	0.9	1.4
8.4	1.0	1.5
8.5	1.1	1.6
8.6	1.1	1.7
8.7	1.2	1.8
8.8	1.3	1.9
8.9	1.3	2.0
9.0	1.4	2.1
9.1	1.5	2.2
9.2	1.5	2.3
9.3	1.6	2.4
9.4	1.7	2.5
9.5	1.7	2.6
9.6	1.8	2.7
9.7	1.9	2.8
9.8	1.9	2.9
9.9	2.0	3.0
10.0	2.1	3.1
10.1	2.1	3.2
10.2	2.2	3.3
10.3	2.3	3.4
10.4	2.3	3.5
10.5	2.4	3.6
10.6	2.5	3.7
10.7	2.5	3.8
10.8	2.6	3.9
10.9	2.7	4.0
11.0	2.7	4.1
11.1	2.8	4.2
11.2	2.9	4.3
11.3	2.9	4.4
11.4	3.0	4.5
11.5	3.1	4.6
11.6	3.1	4.7
11.7	3.2	4.8
11.8	3.3	4.9
11.9	3.3	5.0
12.0	3.4	5.1
12.1	3.5	5.2
12.2	3.5	5.3
12.3	3.6	5.4
12.4	3.7	5.5

Table 3. *Potential water-level rise, in feet, for use with index well Brewster BMW-21*--Continued

WATER	ZONE A	ZONE B
6.9	0.0	0.0
12.5	3.7	5.6
12.6	3.8	5.7
12.7	3.9	5.8
12.8	3.9	5.9
12.9	4.0	6.0
13.0	4.1	6.1
13.1	4.1	6.2
13.2	4.2	6.3
13.3	4.3	6.4
13.4	4.3	6.5
13.5	4.4	6.6
13.6	4.5	6.7
13.7	4.5	6.8
13.8	4.6	6.9
13.9	4.7	7.0
14.0	4.7	7.1
14.1	4.8	7.2
14.2	4.9	7.3
14.3	4.9	7.4
14.4	5.0	7.5
14.5	5.1	7.6
14.6	5.1	7.7
14.7	5.2	7.8
14.8	5.3	7.9
14.9	5.3	8.0
15.0	5.4	8.1
15.1	5.5	8.2
15.2	5.5	8.3
15.3	5.6	8.4
15.4	5.7	8.5
15.5	5.7	8.6
15.6	5.8	8.7
15.7	5.9	8.8
15.8	5.9	8.9
15.9	6.0	9.0
16.0	6.1	9.1
16.1	6.1	9.2
16.2	6.2	9.3
16.3	6.3	9.4
16.4	6.3	9.5
16.5	6.4	9.6
16.6	6.5	9.7
16.7	6.5	9.8
16.8	6.6	9.9
16.9	6.7	10.0
17.0	6.7	10.1
17.1	6.8	10.2
17.2	6.9	10.3
17.3	6.9	10.4
17.4	7.0	10.5
17.5	7.1	10.6
17.6	7.1	10.7
17.7	7.2	10.8
17.8	7.3	10.9
17.9	7.3	11.0

Table 4. *Potential water-level rise, in feet for use with index well Chatham CGW-138*

WATER LEVEL	ZONE A	ZONE B	ZONE C	ZONE D
20.9	0.0	0.0	0.0	0.0
21.0	0.1	0.1	0.1	0.2
21.1	0.1	0.2	0.3	0.3
21.2	0.2	0.3	0.4	0.5
21.3	0.3	0.4	0.5	0.7
21.4	0.3	0.5	0.7	0.8
21.5	0.4	0.6	0.8	1.0
21.6	0.5	0.7	0.9	1.2
21.7	0.5	0.8	1.1	1.3
21.8	0.6	0.9	1.2	1.5
21.9	0.7	1.0	1.3	1.7
22.0	0.7	1.1	1.5	1.8
22.1	0.8	1.2	1.6	2.0
22.2	0.9	1.3	1.7	2.2
22.3	0.9	1.4	1.9	2.3
22.4	1.0	1.5	2.0	2.5
22.5	1.1	1.6	2.1	2.7
22.6	1.1	1.7	2.3	2.8
22.7	1.2	1.8	2.4	3.0
22.8	1.3	1.9	2.5	3.2
22.9	1.3	2.0	2.7	3.3
23.0	1.4	2.1	2.8	3.5
23.1	1.5	2.2	2.9	3.7
23.2	1.5	2.3	3.1	3.8
23.3	1.6	2.4	3.2	4.0
23.4	1.7	2.5	3.3	4.2
23.5	1.7	2.6	3.5	4.3
23.6	1.8	2.7	3.6	4.5
23.7	1.9	2.8	3.7	4.7
23.8	1.9	2.9	3.9	4.8
23.9	2.0	3.0	4.0	5.0
24.0	2.1	3.1	4.1	5.2
24.1	2.1	3.2	4.3	5.3
24.2	2.2	3.3	4.4	5.5
24.3	2.3	3.4	4.5	5.7
24.4	2.3	3.5	4.7	5.8
24.5	2.4	3.6	4.8	6.0
24.6	2.5	3.7	4.9	6.2
24.7	2.5	3.8	5.1	6.3
24.8	2.6	3.9	5.2	6.5
24.9	2.7	4.0	5.3	6.7
25.0	2.7	4.1	5.5	6.8
25.1	2.8	4.2	5.6	7.0
25.2	2.9	4.3	5.7	7.2
25.3	2.9	4.4	5.9	7.3
25.4	3.0	4.5	6.0	7.5
25.5	3.1	4.6	6.1	7.7
25.6	3.1	4.7	6.3	7.8
25.7	3.2	4.8	6.4	8.0
25.8	3.3	4.9	6.5	8.2
25.9	3.3	5.0	6.7	8.3
26.0	3.4	5.1	6.8	8.5
26.1	3.5	5.2	6.9	8.7
26.2	3.5	5.3	7.1	8.8
26.3	3.6	5.4	7.2	9.0
26.4	3.7	5.5	7.3	9.2
26.5	3.7	5.6	7.5	9.3
26.6	3.8	5.7	7.6	9.5
26.7	3.9	5.8	7.7	9.7
26.8	3.9	5.9	7.9	9.8
26.9	4.0	6.0	8.0	10.0
27.0	4.1	6.1	8.1	10.2
27.1	4.1	6.2	8.3	10.3
27.2	4.2	6.3	8.4	10.5
27.3	4.3	6.4	8.5	10.7
27.4	4.3	6.5	8.7	10.8
27.5	4.4	6.6	8.8	11.0
27.6	4.5	6.7	8.9	11.2
27.7	4.5	6.8	9.1	11.3
27.8	4.6	6.9	9.2	11.5
27.9	4.7	7.0	9.3	11.7
28.0	4.7	7.1	9.5	11.8
28.1	4.8	7.2	9.6	12.0
28.2	4.9	7.3	9.7	12.2
28.3	4.9	7.4	9.9	12.3
28.4	5.0	7.5	10.0	12.5
28.5	5.1	7.6	10.1	12.7
28.6	5.1	7.7	10.3	12.8
28.7	5.2	7.8	10.4	13.0
28.8	5.3	7.9	10.5	13.2
28.9	5.3	8.0	10.7	13.3
29.0	5.4	8.1	10.8	13.5
29.1	5.5	8.2	10.9	13.7
29.2	5.5	8.3	11.1	13.8
29.3	5.6	8.4	11.2	14.0
29.4	5.7	8.5	11.3	14.2
29.5	5.7	8.6	11.5	14.3
29.6	5.8	8.7	11.6	14.5
29.7	5.9	8.8	11.7	14.7
29.8	5.9	8.9	11.9	14.8
29.9	6.0	9.0	12.0	15.0
30.0	6.1	9.1	12.1	15.2
30.1	6.1	9.2	12.3	15.3
30.2	6.2	9.3	12.4	15.5
30.3	6.3	9.4	12.5	15.7
30.4	6.3	9.5	12.7	15.8
30.5	6.4	9.6	12.8	16.0
30.6	6.5	9.7	12.9	16.2
30.7	6.5	9.8	13.1	16.3
30.8	6.6	9.9	13.2	16.5
30.9	6.7	10.0	13.3	16.7
31.0	6.7	10.1	13.5	16.8
31.1	6.8	10.2	13.6	17.0
31.2	6.9	10.3	13.7	17.2
31.3	6.9	10.4	13.9	17.3

Table 5. *Potential water-level rise, in feet, for use with index well Mashpee MIW-29*

WATER LEVEL	ZONE A	ZONE B	ZONE C
5.7	0	0.0	0.0
5.8	0.1	0.1	0.1
5.9	0.1	0.2	0.3
6.0	0.2	0.3	0.4
6.1	0.3	0.4	0.5
6.2	0.3	0.5	0.7
6.3	0.4	0.6	0.8
6.4	0.5	0.7	0.9
6.5	0.5	0.8	1.1
6.6	0.6	0.9	1.2
6.7	0.7	1.0	1.3
6.8	0.7	1.1	1.5
6.9	0.8	1.2	1.6
7.0	0.9	1.3	1.7
7.1	0.9	1.4	1.9
7.2	1.0	1.5	2.0
7.3	1.1	1.6	2.1
7.4	1.1	1.7	2.3
7.5	1.2	1.8	2.4
7.6	1.3	1.9	2.5
7.7	1.3	2.0	2.7
7.8	1.4	2.1	2.8
7.9	1.5	2.2	2.9
8.0	1.5	2.3	3.1
8.1	1.6	2.4	3.2
8.2	1.7	2.5	3.3
8.3	1.7	2.6	3.5
8.4	1.8	2.7	3.6
8.5	1.9	2.8	3.7
8.6	1.9	2.9	3.9
8.7	2.0	3.0	4.0
8.8	2.1	3.1	4.1
8.9	2.1	3.2	4.3
9.0	2.2	3.3	4.4
9.1	2.3	3.4	4.5
9.2	2.3	3.5	4.7
9.3	2.4	3.6	4.8
9.4	2.5	3.7	4.9
9.5	2.5	3.8	5.1
9.6	2.6	3.9	5.2
9.7	2.7	4.0	5.3
9.8	2.7	4.1	5.5
9.9	2.8	4.2	5.6
10.0	2.9	4.3	5.7
10.1	2.9	4.4	5.9
10.2	3.0	4.5	6.0
10.3	3.1	4.6	6.1
10.4	3.1	4.7	6.3
10.5	3.2	4.8	6.4
10.6	3.3	4.9	6.5
10.7	3.3	5.0	6.7
10.8	3.4	5.1	6.8
10.9	3.5	5.2	6.9
11.0	3.5	5.3	7.1
11.1	3.6	5.4	7.2
11.2	3.7	5.5	7.3
11.3	3.7	5.6	7.5
11.4	3.8	5.7	7.6
11.5	3.9	5.8	7.7
11.6	3.9	5.9	7.9
11.7	4.0	6.0	8.0
11.8	4.1	6.1	8.1
11.9	4.1	6.2	8.3
12.0	4.2	6.3	8.4
12.1	4.3	6.4	8.5
12.2	4.3	6.5	8.7
12.3	4.4	6.6	8.8
12.4	4.5	6.7	8.9
12.5	4.5	6.8	9.1
12.6	4.6	6.9	9.2
12.7	4.7	7.0	9.3
12.8	4.7	7.1	9.5
12.9	4.8	7.2	9.6
13.0	4.9	7.3	9.7
13.1	4.9	7.4	9.9
13.2	5.0	7.5	10.0
13.3	5.1	7.6	10.1
13.4	5.1	7.7	10.3
13.5	5.2	7.8	10.4
13.6	5.3	7.9	10.5
13.7	5.3	8.0	10.7
13.8	5.4	8.1	10.8
13.9	5.5	8.2	10.9
14.0	5.5	8.3	11.1
14.1	5.6	8.4	11.2
14.2	5.7	8.5	11.3
14.3	5.7	8.6	11.5
14.4	5.8	8.7	11.6
14.5	5.9	8.8	11.7
14.6	5.9	8.9	11.9
14.7	6.0	9.0	12.0
14.8	6.1	9.1	12.1
14.9	6.1	9.2	12.3
15.0	6.2	9.3	12.4
15.1	6.3	9.4	12.5

Table 6. *Potential water-level rise, in feet, for use with index well Sandwich SDW-252*

WATER LEVEL	ZONE A	ZONE B
45.9	0.0	0.0
46.0	0.1	0.2
46.1	0.2	0.3
46.2	0.3	0.5
46.3	0.4	0.6
46.4	0.5	0.8
46.5	0.6	0.9
46.6	0.7	1.1
46.7	0.8	1.2
46.8	0.9	1.4
46.9	1.0	1.5
47.0	1.1	1.7
47.1	1.2	1.8
47.2	1.3	2.0
47.3	1.4	2.1
47.4	1.5	2.3
47.5	1.6	2.4
47.6	1.7	2.6
47.7	1.8	2.7
47.8	1.9	2.9
47.9	2.0	3.0
48.0	2.1	3.2
48.1	2.2	3.3
48.2	2.3	3.5
48.3	2.4	3.6
48.4	2.5	3.8
48.5	2.6	3.9
48.6	2.7	4.1
48.7	2.8	4.2
48.8	2.9	4.4
48.9	3.0	4.5
49.0	3.1	4.7
49.1	3.2	4.8
49.2	3.3	5.0
49.3	3.4	5.1
49.4	3.5	5.3
49.5	3.6	5.4
49.6	3.7	5.6
49.7	3.8	5.7
49.8	3.9	5.9
49.9	4.0	6.0
50.0	4.1	6.2
50.1	4.2	6.3
50.2	4.3	6.5
50.3	4.4	6.6
50.4	4.5	6.8
50.5	4.6	6.9
50.6	4.7	7.1
50.7	4.8	7.2
50.8	4.9	7.4
50.9	5.0	7.5
51.0	5.1	7.7
51.1	5.2	7.8
51.2	5.3	8.0
51.3	5.4	8.1
51.4	5.5	8.3
51.5	5.6	8.4
51.6	5.7	8.6
51.7	5.8	8.7
51.8	5.9	8.9
51.9	6.0	9.0
52.0	6.1	9.2
52.1	6.2	9.3
52.2	6.3	9.5
52.3	6.4	9.6
52.4	6.5	9.8
52.5	6.6	9.9
52.6	6.7	10.1
52.7	6.8	10.2
52.8	6.9	10.4
52.9	7.0	10.5
53.0	7.1	10.7
53.1	7.2	10.8
53.2	7.3	11.0
53.3	7.4	11.1

Table 7. *Potential water-level rise, in feet, for use with index well Sandwich SDW-253*

WATER LEVEL	ZONE A	ZONE B	ZONE C
45.8	0.0	0.0	0.0
45.9	0.1	0.1	0.1
46.0	0.1	0.2	0.3
46.1	0.2	0.3	0.4
46.2	0.3	0.4	0.5
46.3	0.3	0.5	0.7
46.4	0.4	0.6	0.8
46.5	0.5	0.7	0.9
46.6	0.5	0.8	1.1
46.7	0.6	0.9	1.2
46.8	0.7	1.0	1.3
46.9	0.7	1.1	1.5
47.0	0.8	1.2	1.6
47.1	0.9	1.3	1.7
47.2	0.9	1.4	1.9
47.3	1.0	1.5	2.0
47.4	1.1	1.6	2.1
47.5	1.1	1.7	2.3
47.6	1.2	1.8	2.4
47.7	1.3	1.9	2.5
47.8	1.3	2.0	2.7
47.9	1.4	2.1	2.8
48.0	1.5	2.2	2.9
48.1	1.5	2.3	3.1
48.2	1.6	2.4	3.2
48.3	1.7	2.5	3.3
48.4	1.7	2.6	3.5
48.5	1.8	2.7	3.6
48.6	1.9	2.8	3.7
48.7	1.9	2.9	3.9
48.8	2.0	3.0	4.0
48.9	2.1	3.1	4.1
49.0	2.1	3.2	4.3
49.1	2.2	3.3	4.4
49.2	2.3	3.4	4.5
49.3	2.3	3.5	4.7
49.4	2.4	3.6	4.8
49.5	2.5	3.7	4.9
49.6	2.5	3.8	5.1
49.7	2.6	3.9	5.2
49.8	2.7	4.0	5.3
49.9	2.7	4.1	5.5
50.0	2.8	4.2	5.6
50.1	2.9	4.3	5.7
50.2	2.9	4.4	5.9
50.3	3.0	4.5	6.0
50.4	3.1	4.6	6.1
50.5	3.1	4.7	6.3
50.6	3.2	4.8	6.4
50.7	3.3	4.9	6.5
50.8	3.3	5.0	6.7
50.9	3.4	5.1	6.8
51.0	3.5	5.2	6.9
51.1	3.5	5.3	7.1
51.2	3.6	5.4	7.2
51.3	3.7	5.5	7.3
51.4	3.7	5.6	7.5
51.5	3.8	5.7	7.6
51.6	3.9	5.8	7.7
51.7	3.9	5.9	7.9
51.8	4.0	6.0	8.0
51.9	4.1	6.1	8.1
52.0	4.1	6.2	8.3
52.1	4.2	6.3	8.4
52.2	4.3	6.4	8.5
52.3	4.3	6.5	8.7
52.4	4.4	6.6	8.8
52.5	4.5	6.7	8.9
52.6	4.5	6.8	9.1
52.7	4.6	6.9	9.2
52.8	4.7	7.0	9.3
52.9	4.7	7.1	9.5
53.0	4.8	7.2	9.6
53.1	4.9	7.3	9.7
53.2	4.9	7.4	9.9
53.3	5.0	7.5	10.0
53.4	5.1	7.6	10.1
53.5	5.1	7.7	10.3
53.6	5.2	7.8	10.4
53.7	5.3	7.9	10.5
53.8	5.3	8.0	10.7
53.9	5.4	8.1	10.8
54.0	5.5	8.2	10.9
54.1	5.5	8.3	11.1
54.2	5.6	8.4	11.2
54.3	5.7	8.5	11.3
54.4	5.7	8.6	11.5
54.5	5.8	8.7	11.6
54.6	5.9	8.8	11.7
54.7	5.9	8.9	11.9
54.8	6.0	9.0	12.0
54.9	6.1	9.1	12.1
55.0	6.1	9.2	12.3
55.1	6.2	9.3	12.4
55.2	6.3	9.4	12.5
55.3	6.3	9.5	12.7
55.4	6.4	9.6	12.8
55.5	6.5	9.7	12.9
55.6	6.5	9.8	13.1
55.7	6.6	9.9	13.2

Table 7. *Potential water-level rise, in feet, for use with index well Sandwich SDW-253*--Continued

WATER LEVEL	ZONE A	ZONE B	ZONE C
55.8	6.7	10.0	13.3
55.9	6.7	10.1	13.5
56.0	6.8	10.2	13.6
56.1	6.9	10.3	13.7
56.2	6.9	10.4	13.9
56.3	7.0	10.5	14.0
56.4	7.1	10.6	14.1
56.5	7.1	10.7	14.3
56.6	7.2	10.8	14.4
56.7	7.3	10.9	14.5
56.8	7.3	11.0	14.7
56.9	7.4	11.1	14.8
57.0	7.5	11.2	14.9
57.1	7.5	11.3	15.1
57.2	7.6	11.4	15.2
57.3	7.7	11.5	15.3
57.4	7.7	11.6	15.5
57.5	7.8	11.7	15.6
57.6	7.9	11.8	15.7
57.7	7.9	11.9	15.9
57.8	8.0	12.0	16.0
57.9	8.1	12.1	16.1
58.0	8.1	12.2	16.3
58.1	8.2	12.3	16.4
58.2	8.3	12.4	16.5
58.3	8.3	12.5	16.7
58.4	8.4	12.6	16.8
58.5	8.5	12.7	16.9
58.6	8.5	12.8	17.1
58.7	8.6	12.9	17.2
58.8	8.7	13.0	17.3
58.9	8.7	13.1	17.5
59.0	8.8	13.2	17.6
59.1	8.9	13.3	17.7
59.2	8.9	13.4	17.9
59.3	9.0	13.5	18.0
59.4	9.1	13.6	18.1
59.5	9.1	13.7	18.3
59.6	9.2	13.8	18.4
59.7	9.3	13.9	18.5

Table 8. *Potential water-level rise, in feet, for use with index well Truro TSW-89*

WATER LEVEL	ZONE A	ZONE B	ZONE C
10.2	0.0	0.0	0.0
10.3	0.1	0.2	0.2
10.4	0.2	0.3	0.4
10.5	0.3	0.5	0.6
10.6	0.4	0.6	0.8
10.7	0.5	0.8	1.0
10.8	0.6	0.9	1.2
10.9	0.7	1.1	1.4
11.0	0.8	1.2	1.6
11.1	0.9	1.4	1.8
11.2	1.0	1.5	2.0
11.3	1.1	1.7	2.2
11.4	1.2	1.8	2.4
11.5	1.3	2.0	2.6
11.6	1.4	2.1	2.8
11.7	1.5	2.3	3.0
11.8	1.6	2.4	3.2
11.9	1.7	2.6	3.4
12.0	1.8	2.7	3.6
12.1	1.9	2.9	3.8
12.2	2.0	3.0	4.0
12.3	2.1	3.2	4.2
12.4	2.2	3.3	4.4
12.5	2.3	3.5	4.6
12.6	2.4	3.6	4.8
12.7	2.5	3.8	5.0
12.8	2.6	3.9	5.2
12.9	2.7	4.1	5.4
13.0	2.8	4.2	5.6
13.1	2.9	4.4	5.8
13.2	3.0	4.5	6.0
13.3	3.1	4.7	6.2
13.4	3.2	4.8	6.4
13.5	3.3	5.0	6.6
13.6	3.4	5.1	6.8
13.7	3.5	5.3	7.0
13.8	3.6	5.4	7.2
13.9	3.7	5.6	7.4
14.0	3.8	5.7	7.6
14.1	3.9	5.9	7.8
14.2	4.0	6.0	8.0
14.3	4.1	6.2	8.2
14.4	4.2	6.3	8.4
14.5	4.3	6.5	8.6
14.6	4.4	6.6	8.8
14.7	4.5	6.8	9.0
14.8	4.6	6.9	9.2
14.9	4.7	7.1	9.4
15.0	4.8	7.2	9.6
15.1	4.9	7.4	9.8
15.2	5.0	7.5	10.0
15.3	5.1	7.7	10.2
15.4	5.2	7.8	10.4
15.5	5.3	8.0	10.6
15.6	5.4	8.1	10.8
15.7	5.5	8.3	11.0
15.8	5.6	8.4	11.2
15.9	5.7	8.6	11.4
16.0	5.8	8.7	11.6
16.1	5.9	8.9	11.8
16.2	6.0	9.0	12.0
16.3	6.1	9.2	12.2
16.4	6.2	9.3	12.4
16.5	6.3	9.5	12.6
16.6	6.4	9.6	12.8
16.7	6.5	9.8	13.0
16.8	6.6	9.9	13.2
16.9	6.7	10.1	13.4
17.0	6.8	10.2	13.6
17.1	6.9	10.4	13.8
17.2	7.0	10.5	14.0
17.3	7.1	10.7	14.2
17.4	7.2	10.8	14.4
17.5	7.3	11.0	14.6
17.6	7.4	11.1	14.8
17.7	7.5	11.3	15.0
17.8	7.6	11.4	15.2
17.9	7.7	11.6	15.4
18.0	7.8	11.7	15.6
18.1	7.9	11.9	15.8

Table 9. *Potential water-level rise, in feet, for use with index well Wellfleet WNW-17*

WATER LEVEL	ZONE A	ZONE B	ZONE C
7.3	0.0	0.0	0.0
7.4	0.1	0.1	0.1
7.5	0.1	0.1	0.2
7.6	0.2	0.2	0.3
7.7	0.2	0.3	0.4
7.8	0.3	0.3	0.5
7.9	0.3	0.4	0.6
8.0	0.4	0.5	0.7
8.1	0.4	0.5	0.8
8.2	0.5	0.6	0.9
8.3	0.5	0.7	1.0
8.4	0.6	0.7	1.1
8.5	0.6	0.8	1.2
8.6	0.7	0.9	1.3
8.7	0.7	0.9	1.4
8.8	0.8	1.0	1.5
8.9	0.8	1.1	1.6
9.0	0.9	1.1	1.7
9.1	0.9	1.2	1.8
9.2	1.0	1.3	1.9
9.3	1.0	1.3	2.0
9.4	1.1	1.4	2.1
9.5	1.1	1.5	2.2
9.6	1.2	1.5	2.3
9.7	1.2	1.6	2.4
9.8	1.3	1.7	2.5
9.9	1.3	1.7	2.6
10.0	1.4	1.8	2.7
10.1	1.4	1.9	2.8
10.2	1.5	1.9	2.9
10.3	1.5	2.0	3.0
10.4	1.6	2.1	3.1
10.5	1.6	2.1	3.2
10.6	1.7	2.2	3.3
10.7	1.7	2.3	3.4
10.8	1.8	2.3	3.5
10.9	1.8	2.4	3.6
11.0	1.9	2.5	3.7
11.1	1.9	2.5	3.8
11.2	2.0	2.6	3.9
11.3	2.0	2.7	4.0
11.4	2.1	2.7	4.1
11.5	2.1	2.8	4.2
11.6	2.2	2.9	4.3
11.7	2.2	2.9	4.4
11.8	2.3	3.0	4.5
11.9	2.3	3.1	4.6
12.0	2.4	3.1	4.7
12.1	2.4	3.2	4.8
12.2	2.5	3.3	4.9
12.3	2.5	3.3	5.0
12.4	2.6	3.4	5.1
12.5	2.6	3.5	5.2
12.6	2.7	3.5	5.3
12.7	2.7	3.6	5.4
12.8	2.8	3.7	5.5
12.9	2.8	3.7	5.6
13.0	2.9	3.8	5.7
13.1	2.9	3.9	5.8
13.2	3.0	3.9	5.9
13.3	3.0	4.0	6.0
13.4	3.1	4.1	6.1
13.5	3.1	4.1	6.2
13.6	3.2	4.2	6.3
13.7	3.2	4.3	6.4
13.8	3.3	4.3	6.5
13.9	3.3	4.4	6.6
14.0	3.4	4.5	6.7
14.1	3.4	4.5	6.8
14.2	3.5	4.6	6.9
14.3	3.5	4.7	7.0
14.4	3.6	4.7	7.1
14.5	3.6	4.8	7.2
14.6	3.7	4.9	7.3
14.7	3.7	4.9	7.4
14.8	3.8	5.0	7.5
14.9	3.8	5.1	7.6
15.0	3.9	5.1	7.7
15.1	3.9	5.2	7.8
15.2	4.0	5.3	7.9
15.3	4.0	5.3	8.0
15.4	4.1	5.4	8.1
15.5	4.1	5.5	8.2
15.6	4.2	5.5	8.3
15.7	4.2	5.6	8.4
15.8	4.3	5.7	8.5
15.9	4.3	5.7	8.6
16.0	4.4	5.8	8.7
16.1	4.4	5.9	8.8
16.2	4.5	5.9	8.9
16.3	4.5	6.0	9.0
16.4	4.6	6.1	9.1
16.5	4.6	6.1	9.2
16.6	4.7	6.2	9.3
16.7	4.7	6.3	9.4
16.8	4.8	6.3	9.5
16.9	4.8	6.4	9.6
17.0	4.9	6.5	9.7
17.1	4.9	6.5	9.8
17.2	5.0	6.6	9.9
17.3	5.0	6.7	10.0
17.4	5.1	6.7	10.1
17.5	5.1	6.8	10.2
17.6	5.2	6.9	10.3
17.7	5.2	6.9	10.4

CAPE COD COMMISSION

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To: Interested Persons
From: Gabrielle Belfit, Hydrologist
Date: December 30, 1992
RE: USGS INDEX WELLS

Thank you for your recent attendance at the Barnstable County Health Agents Workshop on High Groundwater. Enclosed is a copy of revised Tables 5 and 6 that include the Zone D ranges for SDW 252 and MIW 29 which were missing from the recently distributed Cape Cod Commission Technical Bulletin 92-001, "Estimation of High Ground-Water Levels for Construction and Land Use Planning- A Cape Cod , Massachusetts, Example- Updated 1991. I would suggest stapling this into the back of the Technical Bulletin for easy reference.

Also enclosed are the December 1992 readings for the INDEX WELLS, please note that the list has been revised to accommodate the new publication. This data will be also be published in the **Commission Reporter** in mid-January. Please call this office if you need any assistance, or previous index well readings.

Also included is a December statistical summary sheet which is of interest due to the substantial increase in water levels this month. These are available at any time on request.

Supplement Table 5. Potential water-level rise, in feet, for use with index well Mashpee MIW-29

WATER LEVEL	ZONE A	ZONE B	ZONE C	ZONE D
5.7	0.0	0.0	0.0	0.0
5.8	0.1	0.1	0.1	0.2
5.9	0.1	0.2	0.3	0.3
6.0	0.2	0.3	0.4	0.5
6.1	0.3	0.4	0.5	0.7
6.2	0.3	0.5	0.7	0.8
6.3	0.4	0.6	0.8	1.0
6.4	0.5	0.7	0.9	1.2
6.5	0.5	0.8	1.1	1.3
6.6	0.6	0.9	1.2	1.5
6.7	0.7	1.0	1.3	1.7
6.8	0.7	1.1	1.5	1.8
6.9	0.8	1.2	1.6	2.0
7.0	0.9	1.3	1.7	2.2
7.1	0.9	1.4	1.9	2.3
7.2	1.0	1.5	2.0	2.5
7.3	1.1	1.6	2.1	2.7
7.4	1.1	1.7	2.3	2.8
7.5	1.2	1.8	2.4	3.0
7.6	1.3	1.9	2.5	3.2
7.7	1.3	2.0	2.7	3.3
7.8	1.4	2.1	2.8	3.5
7.9	1.5	2.2	2.9	3.7
8.0	1.5	2.3	3.1	3.8
8.1	1.6	2.4	3.2	4.0
8.2	1.7	2.5	3.3	4.2
8.3	1.7	2.6	3.5	4.3
8.4	1.8	2.7	3.6	4.5
8.5	1.9	2.8	3.7	4.7
8.6	1.9	2.9	3.9	4.8
8.7	2.0	3.0	4.0	5.0
8.8	2.1	3.1	4.1	5.2
8.9	2.1	3.2	4.3	5.3
9.0	2.2	3.3	4.4	5.5

Supplement Table 5. Potential water-level rise, in feet, for use with index well Mashpee MIW-29

WATER LEVEL	ZONE A	ZONE B	ZONE C	ZONE D
9.1	2.3	3.4	4.5	5.7
9.2	2.3	3.5	4.7	5.8
9.3	2.4	3.6	4.8	6.0
9.4	2.5	3.7	4.9	6.2
9.5	2.5	3.8	5.1	6.3
9.6	2.6	3.9	5.2	6.5
9.7	2.7	4.0	5.3	6.7
9.8	2.7	4.1	5.5	6.8
9.9	2.8	4.2	5.6	7.0
10.0	2.9	4.3	5.7	7.2
10.1	2.9	4.4	5.9	7.3
10.2	3.0	4.5	6.0	7.5
10.3	3.1	4.6	6.1	7.7
10.4	3.1	4.7	6.3	7.8
10.5	3.2	4.8	6.4	8.0
10.6	3.3	4.9	6.5	8.2
10.7	3.3	5.0	6.7	8.3
10.8	3.4	5.1	6.8	8.5
10.9	3.5	5.2	6.9	8.7
11.0	3.5	5.3	7.1	8.8
11.1	3.6	5.4	7.2	9.0
11.2	3.7	5.5	7.3	9.2
11.3	3.7	5.6	7.5	9.3
11.4	3.8	5.7	7.6	9.5
11.5	3.9	5.8	7.7	9.7
11.6	3.9	5.9	7.9	9.8
11.7	4.0	6.0	8.0	10.0
11.8	4.1	6.1	8.1	10.2
11.9	4.1	6.2	8.3	10.3
12.0	4.2	6.3	8.4	10.5
12.1	4.3	6.4	8.5	10.7
12.2	4.3	6.5	8.7	10.8
12.3	4.4	6.6	8.8	11.0
12.4	4.5	6.7	8.9	11.2

Supplement Table 5. Potential water-level rise, in feet, for use with index well Mashpee MIW-29

WATER LEVEL	ZONE A	ZONE B	ZONE C	ZONE D
12.5	4.5	6.8	9.1	11.3
12.6	4.6	6.9	9.2	11.5
12.7	4.7	7.0	9.3	11.7
12.8	4.7	7.1	9.5	11.8
12.9	4.8	7.2	9.6	12.0
13.0	4.9	7.3	9.7	12.2
13.1	4.9	7.4	9.9	12.3
13.2	5.0	7.5	10.0	12.5
13.3	5.1	7.6	10.1	12.7
13.4	5.1	7.7	10.3	12.8
13.5	5.2	7.8	10.4	13.0
13.6	5.3	7.9	10.5	13.2
13.7	5.3	8.0	10.7	13.3
13.8	5.4	8.1	10.8	13.5
13.9	5.5	8.2	10.9	13.7
14.0	5.5	8.3	11.1	13.8
14.1	5.6	8.4	11.2	14.0
14.2	5.7	8.5	11.3	14.2
14.3	5.7	8.6	11.5	14.3
14.4	5.8	8.7	11.6	14.5
14.5	5.9	8.8	11.7	14.7
14.6	5.9	8.9	11.9	14.8
14.7	6.0	9.0	12.0	15.0
14.8	6.1	9.1	12.1	15.2
14.9	6.1	9.2	12.3	15.3
15.0	6.2	9.3	12.4	15.5
15.1	6.3	9.4	12.5	15.7

Supplement Table 6. Potential water-level rise, in feet, for use with index well Sandwich-252

WATER LEVEL	ZONE A	ZONE B	ZONE C	ZONE D
45.9	0.0	0.0	0.0	0.0
46.0	0.1	0.2	0.2	0.3
46.1	0.2	0.3	0.4	0.5
46.2	0.3	0.5	0.6	0.8
46.3	0.4	0.6	0.8	1.0
46.4	0.5	0.8	1.0	1.3
46.5	0.6	0.9	1.2	1.5
46.6	0.7	1.1	1.4	1.8
46.7	0.8	1.2	1.6	2.0
46.8	0.9	1.4	1.8	2.3
46.9	1.0	1.5	2.0	2.5
47.0	1.1	1.7	2.2	2.8
47.1	1.2	1.8	2.4	3.0
47.2	1.3	2.0	2.6	3.3
47.3	1.4	2.1	2.8	3.5
47.4	1.5	2.3	3.0	3.8
47.5	1.6	2.4	3.2	4.0
47.6	1.7	2.6	3.4	4.3
47.7	1.8	2.7	3.6	4.5
47.8	1.9	2.9	3.8	4.8
47.9	2.0	3.0	4.0	5.0
48.0	2.1	3.2	4.2	5.3
48.1	2.2	3.3	4.4	5.5
48.2	2.3	3.5	4.6	5.8
48.3	2.4	3.6	4.8	6.0
48.4	2.5	3.8	5.0	6.3
48.5	2.6	3.9	5.2	6.5
48.6	2.7	4.1	5.4	6.8
48.7	2.8	4.2	5.6	7.0
48.8	2.9	4.4	5.8	7.3
48.9	3.0	4.5	6.0	7.5
49.0	3.1	4.7	6.2	7.8
49.1	3.2	4.8	6.4	8.0

Supplement Table 6. Potential water-level rise, in feet, for use with index well Sandwich-252

WATER LEVEL	ZONE A	ZONE B	ZONE C	ZONE D
49.2	3.3	5.0	6.6	8.3
49.3	3.4	5.1	6.8	8.5
49.4	3.5	5.3	7.0	8.8
49.5	3.6	5.4	7.2	9.0
49.6	3.7	5.6	7.4	9.3
49.7	3.8	5.7	7.6	9.5
49.8	3.9	5.9	7.8	9.8
49.9	4.0	6.0	8.0	10.0
50.0	4.1	6.2	8.2	10.3
50.1	4.2	6.3	8.4	10.5
50.2	4.3	6.5	8.6	10.8
50.3	4.4	6.6	8.8	11.0
50.4	4.5	6.8	9.0	11.3
50.5	4.6	6.9	9.2	11.5
50.6	4.7	7.1	9.4	11.8
50.7	4.8	7.2	9.6	12.0
50.8	4.9	7.4	9.8	12.3
50.9	5.0	7.5	10.0	12.5
51.0	5.1	7.7	10.2	12.8
51.1	5.2	7.8	10.4	13.0
51.2	5.3	8.0	10.6	13.3
51.3	5.4	8.1	10.8	13.5
51.4	5.5	8.3	11.0	13.8
51.5	5.6	8.4	11.2	14.0
51.6	5.7	8.6	11.4	14.3
51.7	5.8	8.7	11.6	14.5
51.8	5.9	8.9	11.8	14.8
51.9	6.0	9.0	12.0	15.0
52.0	6.1	9.2	12.2	15.3
52.1	6.2	9.3	12.4	15.5
52.2	6.3	9.5	12.6	15.8
52.3	6.4	9.6	12.8	16.0
52.4	6.5	9.8	13.0	16.3

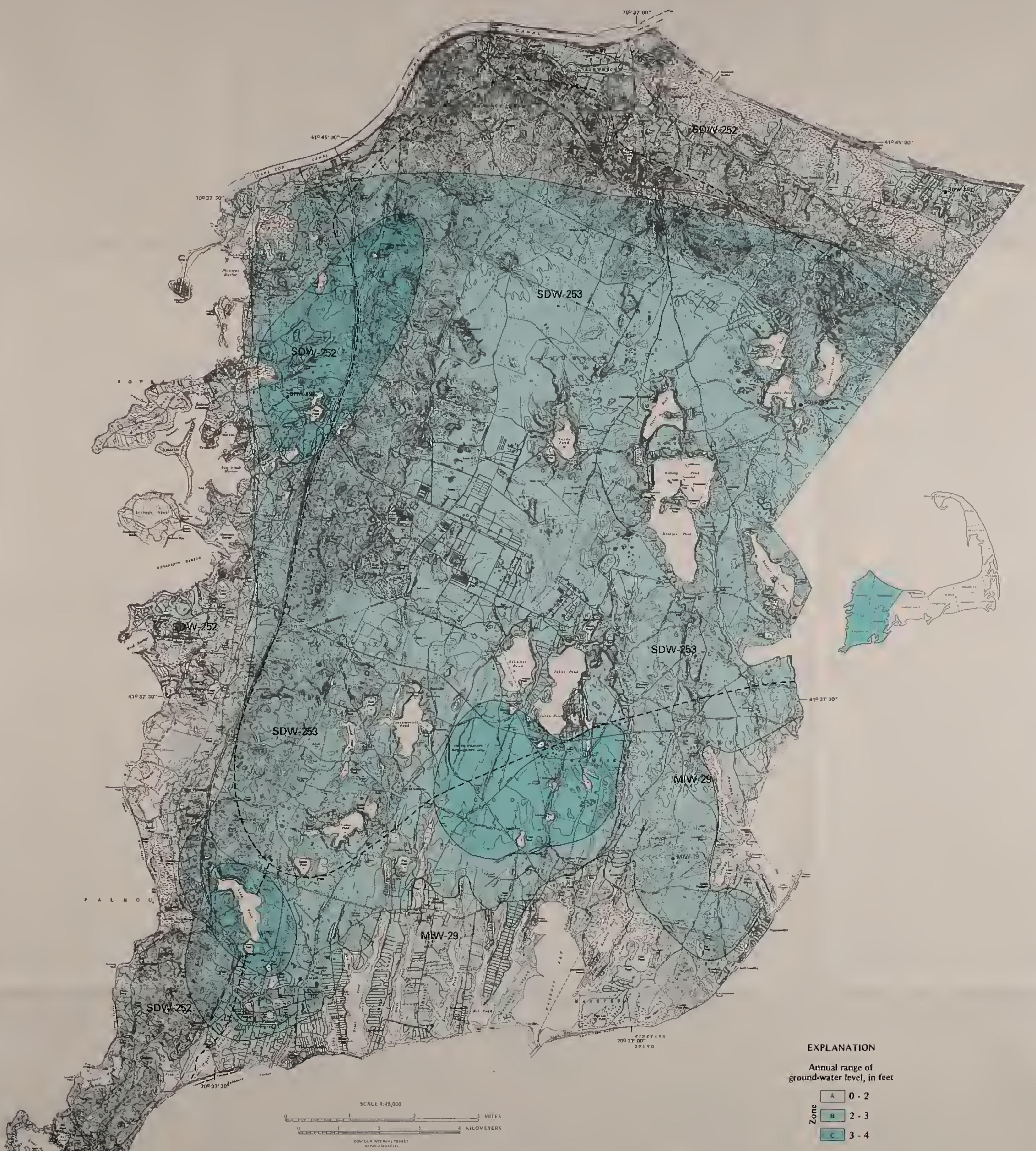
Supplement Table 6. Potential water-level rise, in feet, for use with index well Sandwich-252

WATER LEVEL	ZONE A	ZONE B	ZONE C	ZONE D
52.5	6.6	9.9	13.2	16.5
52.6	6.7	10.1	13.4	16.8
52.7	6.8	10.2	13.6	17.0
52.8	6.9	10.4	13.8	17.3
52.9	7.0	10.5	14.0	17.5
53.0	7.1	10.7	14.2	17.8
53.1	7.2	10.8	14.4	18.0
53.2	7.3	11.0	14.6	18.3

2-001
ATE 1

CAPE COD COMMISSION WATER RESOURCES OFFICE
PREPARED IN COOPERATION WITH
UNITED STATES GEOLOGICAL SURVEY, WATER RESOURCES DIVISION

TECHNICAL BULLETIN 92-001
PLATE 1



EXPLANATION

Annual range of ground-water level, in feet

Zone	
A	0 - 2
B	2 - 3
C	3 - 4

Water level ranges are not shown in wetlands, marshes, and water bodies where the technique described in this report is generally not applicable. Field investigation to determine on-site conditions is needed in these areas for proper evaluation of site suitability for application of technique.

Identification number is the local well number, which consists of a three-character alphanumeric code indicating the town, and a sequential number assigned by the U.S. Geological Survey for wells within that town.

MIW-29

Index observation well to be used for area delineated by dashed line.

•SDW-253

Index observation well location and identification number.

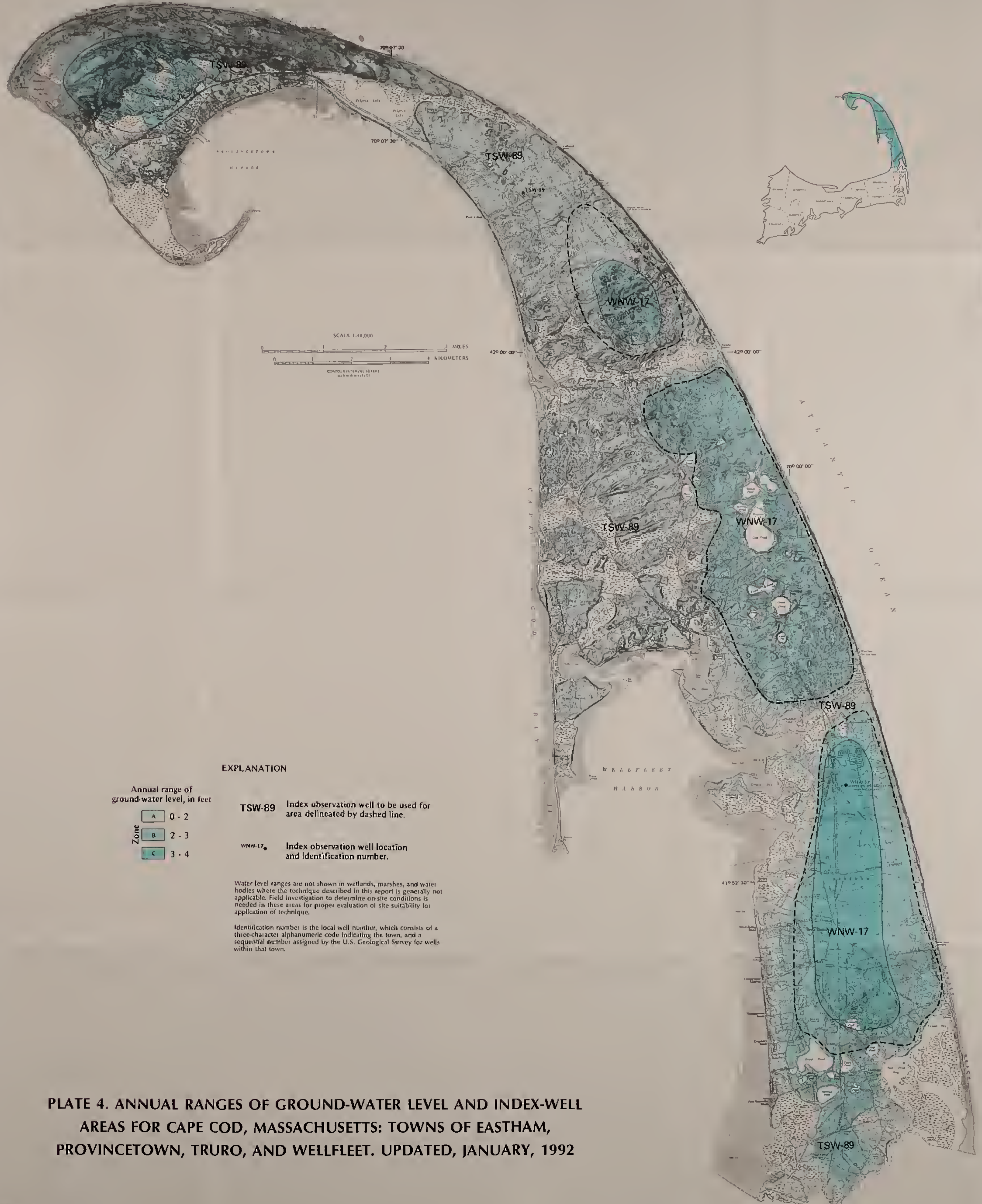
Modified from U.S. Geological Survey
Water-Resources Investigations 83-4112

Base from U.S. Geological Survey
1:24,000 quadrangles.

PLATE 1. ANNUAL RANGES OF GROUND-WATER LEVEL AND INDEX-WELL AREAS FOR CAPE COD, MASSACHUSETTS: TOWNS OF BOURNE, FALMOUTH, MASHPEE, AND SANDWICH. UPDATED, JANUARY, 1992.

CAPE COD COMMISSION WATER RESOURCES OFFICE
PREPARED IN COOPERATION WITH
UNITED STATES GEOLOGICAL SURVEY, WATER RESOURCES DIVISION

TECHNICAL BULLETIN 92-001
PLATE 4



EXPLANATION

Annual range of ground-water level, in feet

Zone	
A	0 - 2
B	2 - 3
C	3 - 4

TSW-89	Index observation well to be used for area delineated by dashed line.
WNW-17●	Index observation well location and identification number.

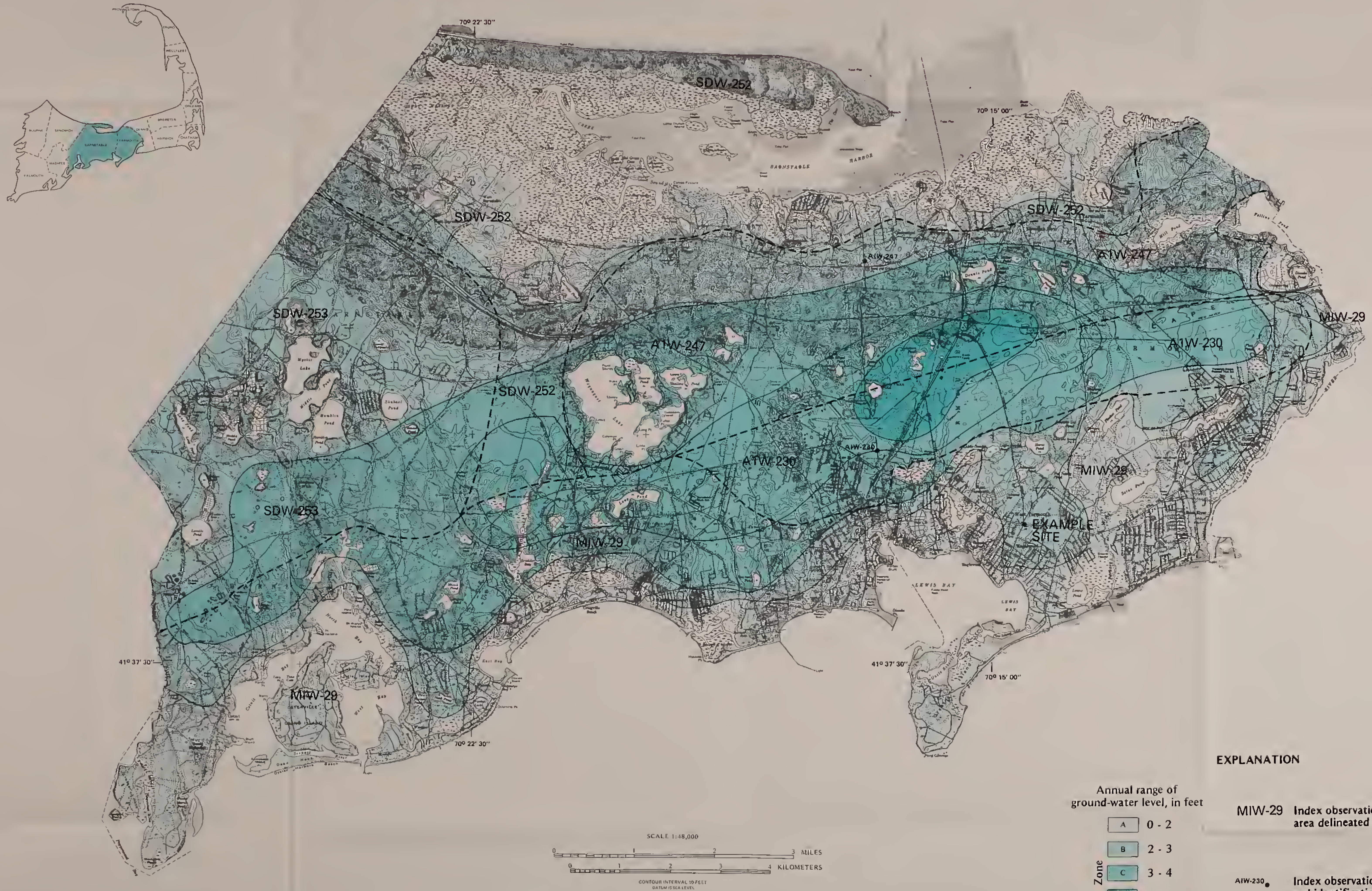
Water level ranges are not shown in wetlands, marshes, and water bodies where the technique described in this report is generally not applicable. Field investigation to determine on-site conditions is needed in these areas for proper evaluation of site suitability for application of technique.

Identification number is the local well number, which consists of a three-character alphanumeric code indicating the town, and a sequential number assigned by the U.S. Geological Survey for wells within that town.

PLATE 4. ANNUAL RANGES OF GROUND-WATER LEVEL AND INDEX-WELL AREAS FOR CAPE COD, MASSACHUSETTS: TOWNS OF EASTHAM, PROVINCETOWN, TRURO, AND WELLFLEET. UPDATED, JANUARY, 1992

Modified from U.S. Geological Survey
Water-Resources Investigations 83-4112

Base from U.S. Geological Survey
1:24,000 quadrangles



EXPLANATION

Annual range of ground-water level, in feet

Zone	
A	0 - 2
B	2 - 3
C	3 - 4
D	4 - 5
E	5 - 6

MIW-29 Index observation well to be used for area delineated by dashed line.

AIW-230● Index observation well location and identification number.

Water level ranges are not shown in wetlands, marshes, and water bodies where the technique described in this report is generally not applicable. Field investigation to determine on-site conditions is needed in these areas for proper evaluation of site suitability for application of technique.

Identification number is the local well number, which consists of a three-character alphanumeric code indicating the town, and a sequential number assigned by the U.S. Geological Survey for wells within that town.

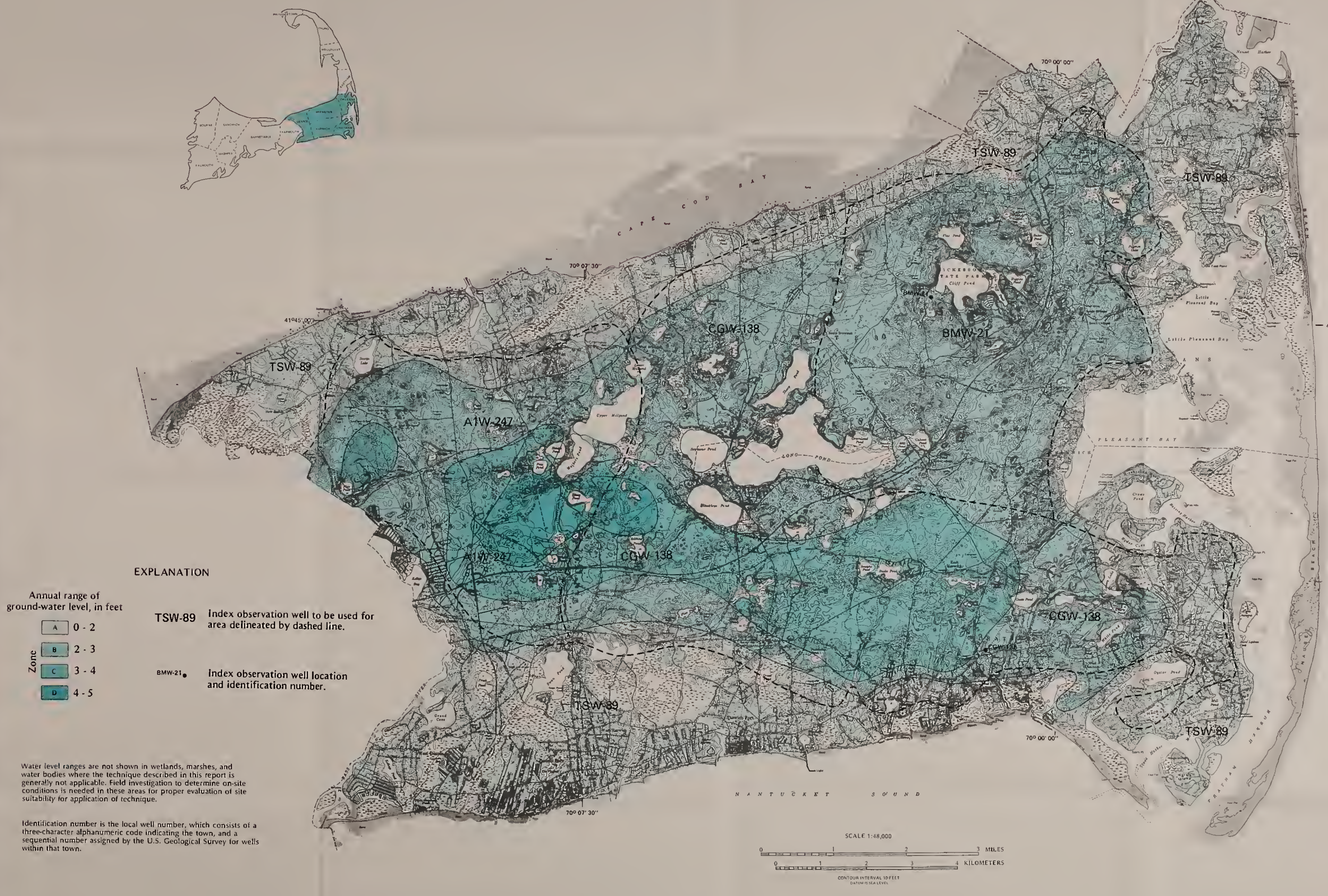
Modified from U.S. Geological Survey
Water Resources Investigations 83-4112

Base from U.S. Geological Survey
1:24,000 quadrangles.

PLATE 2. ANNUAL RANGES OF GROUND-WATER LEVEL AND INDEX-WELL AREAS FOR CAPE COD, MASSACHUSETTS: TOWNS OF BARNSTABLE AND YARMOUTH. UPDATED JANUARY, 1992.

CAPE COD COMMISSION WATER RESOURCES OFFICE
PREPARED IN COOPERATION WITH
UNITED STATES GEOLOGICAL SURVEY, WATER RESOURCES DIVISION

TECHNICAL BULLETIN 92-001
PLATE 3



EXPLANATION

Annual range of ground-water level, in feet

Zone	
A	0 - 2
B	2 - 3
C	3 - 4
D	4 - 5

TSW-89 Index observation well to be used for area delineated by dashed line.

BMW-21● Index observation well location and identification number.

Water level ranges are not shown in wetlands, marshes, and water bodies where the technique described in this report is generally not applicable. Field investigation to determine on-site conditions is needed in these areas for proper evaluation of site suitability for application of technique.

Identification number is the local well number, which consists of a three-character alphanumeric code indicating the town, and a sequential number assigned by the U.S. Geological Survey for wells within that town.

Modified from U.S. Geological Survey
Water-Resources Investigations 83-4112

Base from U.S. Geological Survey
1:24,000 quadrangles.

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PLATE 3. ANNUAL RANGES OF GROUND-WATER LEVEL AND INDEX-WELL AREAS FOR CAPE COD, MASSACHUSETTS: TOWNS OF BREWSTER, CHATHAM, DENNIS, HARWICH, AND ORLEANS. UPDATED, JANUARY, 1992.